Partners in Motion
494 Transportation Corridor
ICTM Project

Interim Report #1

Prepared for:

ICTM Evaluation Committee

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1996

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Executive Summary

- **Introduction**

The Minnesota Department of Transportation, in cooperation with Hennepin County and the cities of Bloomington, Edina and Richfield, is conducting an operational test of an integrated corridor traffic management system. The test involves an eight-mile-long segment of I-494 in the Twin Cities metropolitan area and the adjacent arterial street system, shown in Exhibit A. In general, the test involves the phased implementation of an adaptive traffic control system with both freeway ramp meter and arterial traffic signals with the ability to continuously adjust timing plans in response to real-time flow conditions.

This interim report documents the evaluation analysis of the initial ICTM project implementation phase involving Modules 1 and 2 which includes adaptive controls at 27 ramp meters and integration with the existing freeway management system (FMS) as Module 1. Although adaptive control was installed at 2 1 interchange ramp terminal signals as Module 2, they were not operational at the time of this evaluation and will be evaluated under the next project phase of the study which also includes adaptive traffic control at 41 arterial street intersections, as shown on Exhibit B.

- **Test Plans**

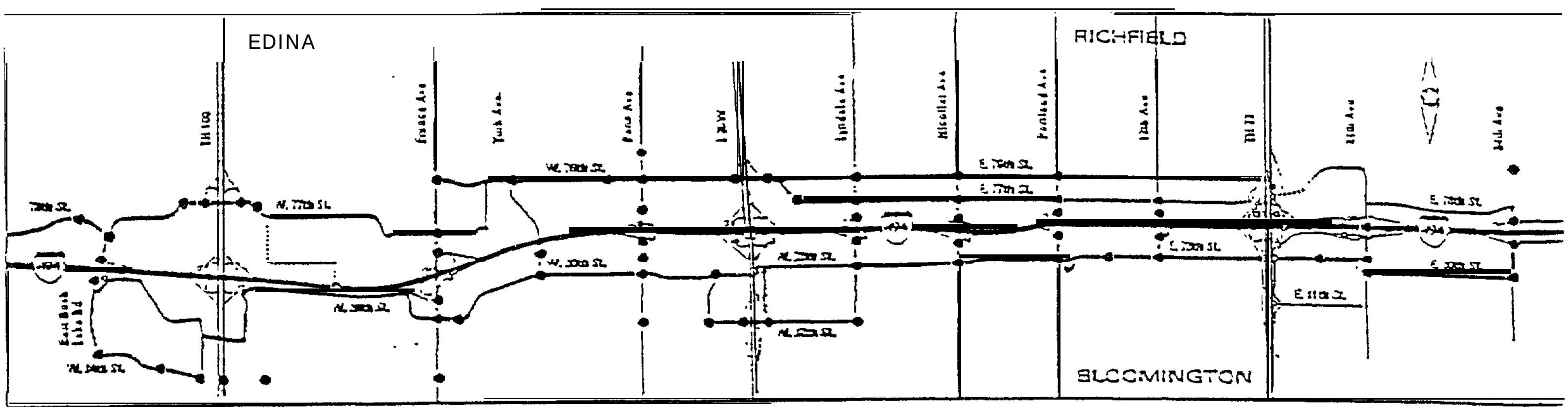
Eight individual test plans (IETPs) involving a total of 47 measures of effectiveness (MOEs) were designed to evaluate the effectiveness of ICTM in the I-494 corridor. The test plans address the following basic evaluation areas:

1. Ability of ICTM to manage corridor traffic conditions during both norrnal and freeway incident time periods;
2. Ability of ICTM to implement an effective motorist information program;
3. Impact of ICTM on bordering traffic control systems;
4. Ability of ICTM to make use of available transportation infrastructure and its expandability or transferability to another area; and
5. Ability of multiple transportation agencies to work together and manage traffic in a congested freeway corridor.

- **System Considerations**

To accurately assess the impact of ICTM, a set of comprehensive data sources were identified. These sources include quantitative traffic engineering measurements, agency and public perceptions, system performance issues and project implementation costs and agreements. Many of these data sources intentionally overlap each other to confirm or support system conclusions. Of the 47 MOEs to be evaluated in this study, 10 MOEs have “before/after” comparative data available for this interim report and another 13 MOEs have “before” baseline data available. The data collected to date, basically during

Exhibit A.



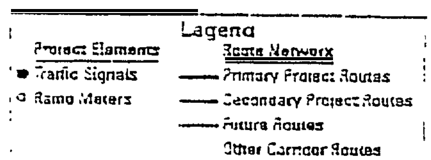


Exhibit B.

ICTM Deployment Plan

1994: Module 1:	1995: Module 2:	1996: Module 3:	1997: Module 4:	1998:
- System Hardware and Software - 21 Traffic Signals - Video Detection at 4 Sites - Develop Communication Plan	- System Integration - 27 Ramp Meters - Develop Operation Plan - Training	- 41 Traffic Signals - 11 CCTV on Arterial System - 2 VMS Freeway - Training - Communication Network	- Motorist Information Devices - Implement Operation Plan - Refine Incident/ Special Event Plan	
		Evaluation Plan		
- Develop Evaluation Plan	- Develop Evaluation Design	- Data Collection - Interim Report 1	- Data Collection - Interim Report 3	- Data Collection - Final Report

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the August-November 1995 and April-May 1996 time periods, are principally limited to reporting on the effectiveness of ramp metering integration with an adaptive traffic control system. The impact of this activity is not considered to have affected arterial street operating conditions which did not have operational adaptive controls. The data available for "before/after" evaluation are contained in evaluation areas 1, 4 and 5, described above and pertain to the following ten MOEs.

1 - 1.1 Increase in screenline traffic volumes during periods of recurrent traffic congestion.

1-l .2 Decrease in travel time through the corridor.

1-l .4 Reduction in queue delays on freeway entrance ramps.

l-4.1 Reduction in speed fluctuations along the freeway attributed to ICTM.

5- 1.1 Document all fixed and on-going costs.

5-l .2 Document public/private sector contributions.

5-3.4 Document critical issues and procedures needed for implementation of the ICTM concept.

5-4.1 Document all multi-agency agreements.

5-4.2 Document all legal or institutional issues encountered and the resolutions to those resolved.

5-4.3 Document policies or procedures altered due to ICTM.

- **Results**

With regard to Evaluation Area 1, the ability of ICTM to manage corridor traffic conditions during periods of normal and freeway incident time periods, it can be seen from Exhibit C, that average I-494 traffic volumes at two control screenlines located east of Nicollet and Xerxes Avenuesincreased during all peak hour time periods when freeway travel speed data was collected. The increase in volume ranged between 2.88 to 7.15 percent during the 7:30 to 8:30 AM and 4:30 to 5:30 PM peak hours and the 6:00 to 9:00 AM and 3:00 to 6:00 PM peak periods. This is contrary to the general freeway traffk screenline pattern which demonstrated a statistical decrease in peak period traffk levels. A review of additional screenline data indicates that the distribution of traffk between the arterial street and the freeway system has not changed greatly with a traffic distribution variance of less than 2.2 percent during the peak and mid-day time periods. It was noted that traffic on 77th Street increased significantly during the study period by a range of +17.5 to 83.2 percent. This increase is attributed to construction activity on 77th Street during the "before" traffk data collection time period. This traffic increase appears to have come from traffic diversion on other parallel east-west streets in the corridor, principally 76th Street. Interestingly, overall traffic levels in the corridor adjusted for seasonal variations, do not appear to have changed between 1995 and 1996.

Exhibit C. ICTM Effect on I-494

Traffic Volume	Travel Speed
• Total freeway traffic data indicates a mixed Variation in volume levels with a significant Reduction during peak time periods except the 7:00 to 8:00 AM peak hour. • Traffic volume distribution between the freeway and arterial system changed by less than 2.2 percent during all peak and mid-day time periods. ↑ Average freeway traffic volumes increased during all peak hour time periods when freeway travel speed data was collected.	↑ Peak period travel speeds increased in 5 out of 8 cases. ↑ Minimum peak period travel speeds were increased from 35 to 48.8 mph.

Ramp Delay*	Travel Speed Uniformity
↓ Average delay per vehicle decreased in 6 out of 13 cases. - Average delays per vehicle were unchanged in 3 other cases. ↓ Total ramp delay for I3 cases was reduced by 11.0 and 93.3 vehicle-hours during the AM and PM peak hours.	↑ Travel speed uniformity was improved in 3 out of 8 cases. - Travel speed uniformity was unchanged in 3 out of 8 cases.. ↑ Traffic speeds in freeway control zones were increased in 5 out of 8 cases.

*Ramp delay results are based on a one day comparative sample.

In comparison to increased freeway traffic volumes, travel speeds on I-494 have improved and become more uniform since implementation of adaptive ramp meter controls. Average travel speeds on I-494 during peak traffic periods, as shown on Exhibit D, increased during five out of eight cases and remained unchanged in the three other cases.

Exhibit D. Average I-494 Travel Speed (East Bush Lake Road to Minnesota River)

Time Period	Direction	Speed (mph)		% Change	
		Before	After		
6:00 – 9:00 AM	EB	56.7	56.5	-0.4	-
	WB	45.4	50.4	11.0	↑
7:30 – 8:30 AM	EB	54.0	52.7	-2.4	-
	WB	35.0	49.8	42.4	↑
3:00 – 6:00 PM	EB	49.2	48.8	-0.8	-
	WB	51.8	55.5	7.1	↑
4:30 – 5:30 PM	EB	44.4	48.8	9.9	↑
	WB	50.3	56.3	11.8	↑

It is also shown on Exhibit D that minimum travel speeds increased and, therefore, with a smaller speed range, it may be concluded that speeds are more uniform.

Travel speed uniformity is related to system reliability and safety. As shown in Exhibit E, travel speed consistency or uniformity (the variance between observed minimum and maximum speeds) was reduced in three out of eight cases and unchanged in three other cases. Travel speeds between adjacent freeway segments (control zones) also increased in five out of eight cases. These changes are not overwhelming supportive of improved speed uniformity on I-494, but do indicate a positive trend with regard to the impact of adaptive ramp meter control.

Exhibit E. I-494 Travel Speed Consistency

Time Period	Direction	Speed Range Change (mph)	% Change	
6:00 - 9:00 AM	EB	-6	-11.8	↓
	WB	-5	-8.9	↓
7:30 - 8:30 AM	EB	-2	-4.3	—
	WB	-1	-2.0	—
3:00 - 6:00 PM	EB	+6	14.0	↑
	WB	+2	4.2	—
4:30 - 5:30 pm	EB	+6	14.0	↑
	WB	-7	-14.6	↓

Finally, as shown on Exhibit F, ramp meter delays were reduced at six of 13 on-ramp measurements during peak traffic periods and unchanged in three other cases.

Exhibit F. I-494 Ramp Delay*

Ramp	Direction	Time Period: 7:30 - 8:30 AM Ave. delay (min)		4:30 - 5:30 PM Ave. delay (min)	
4D4	EB	-0.09	—	0.71	↑
4E1	EB	-0.03	—	-0.21	—
4E4	EB	n/a		-1.44	↓
4G2	WB	1.09	↑	-10.51	↓
4G7	WB	-1.37	↓	-3.68	↓
4H2	WB	-5.21	↓	1.77	↑
4H4	WB	3.04	↑	-6.51	↓

* Ramp delay results are based on a one day comparative sample.

The most significant finding from this ramp delay data involves the cumulative reduction in delay experienced by motorists during the 7:30 to 8:30 AM and 4:30 to 5:30 PM peak hours, when total rarnp delay was reduced by 11 .O and 93.3 vehicles hours.

In addition to the above results directly related to ICTM deployment, the following baseline traffic safety and motorist perceptions were documented for analysis in subsequent reports:

– Baseline traffic conditions for 1994 indicate that there were 754 arterial street accidents in the study corridor, of which 22 percent occurred on east-west streets and were evenly distributed between 76th, 79th and 80th Streets. Of the remaining 78 percent that occurred on north-south streets, the highest accident frequencies were reported on France, Portland and Penn Avenues, in addition to the I-35W and TH77 freeway facilities.

– Motorists indicated there were very few concerns of unsafe driving conditions on the arterial street system in the I-494 corridor. Motorists did feel, however, frustration with inefficient signal timing on the arterial street system. Motorists indicated they only occasionally used the arterial street system prior to ICTM. Over 56 percent of surveyed motorists indicated they are "very" or "extremely likely" to use the freeway system for short trips. Potential changes to these safety and travel pattern perceptions as a result of ICTM will be verified in future ICTM evaluation reports.

In addition to these traffic operation changes, this test also documented project costs and agreements, The cost of implementing an ICTM system provides important information for future projects that look to expand the system in the Twin Cities area or start a system in another community. The total cost to date is $4.3 1 million which includes fixed, capital expenditures for: 1) project development; 2) adaptive signal controls; 3) adaptive ramp meter control; and 4) alternative detection technology development, in addition to ongoing operating costs, as shown in Exhibit G. This cost includes $1.44 million dollars which have been provided in "hard" and "soft" contributions by MnDOT, local agencies and the private sector.

Exhibit G. Summary of ICTM Costs for Modules 1 and 2

Costs	(dollars)	% Total
1. Fixed		
Project Development	$656,900	22.9
Adaptive Traffic Signal Control	873,400	30.4
Adaptive Ramp Meter Control	417,000	14.5
Alternative Detection Technology	332,800	11.6
Subtotal	$2,280,100	79.4
2. Ongoing (Operations/Maintenance)	592,400	20.6
TOTAL	$2.872.500	100.0%

For estimation purposes, preliminary unit costs for adaptive control are:

- $300,000 per mile of freeway
- $100,000 per mile of arterial
- $115,000 per freeway ramp terminal intersection

These unit costs are not additive but reflect the total cost of $2,872,500, as shown in Exhibit G, divided by 7.9 miles of freeway, 22.7 miles of arterial, or 20 ramp terminals.

In addition to these cost contributions, each community directly involved in the ICTM transportation corridor have agreed to cooperate on the operation of the system. System operating principals and cooperative agreements have been approved by each community on project cost sharing, maintenance and operation. Project design, deployment and operation issues are agreed to at monthly ICTM management team meetings with MnDOT serving as the principal lead agency for ICTM design and contracting.

With regard to potential liability issues, several standard procedures were identified for system maintenance specific to record keeping, scheduling, uniform practices and communication. No liability claims have been reported to date due to ICTM system operation. A potential liability exposure area could occur when an agency is assisting with traffic maintenance outside the agency's jurisdictional boundaries or in another agency's traffic control cabinet within its jurisdictional area. The agreements developed for the ICTM project and the use of good maintenance procedures should protect against this potential problem. In general, cooperation and management between the agencies affected by ICTM has been very strong and successful.

This interim report is the first in a series of evaluation reports on the ICTM project. Deployment of Module 4 is scheduled for completion in the spring of 1998. Exhibit H identifies the remaining evaluation activity schedule through completion of the final report in October of 1998.

Exhibit H. ICTM Evaluation Schedule

Activity	Completion Period
1. Operator Interviews	March 1997
2. Module 3 Traffic Data Collection	May 1997
3. Interim Report No. 2	September 1997
4. Operator Interviews	March 1998
5. Business/Resident Focus Group	April 1998
6. Motorist Telephone Survey	April 1998
7. Module 4 Traffic Data Collection	May 1998
8. ICTM Final Report	October 1998

I. Introduction

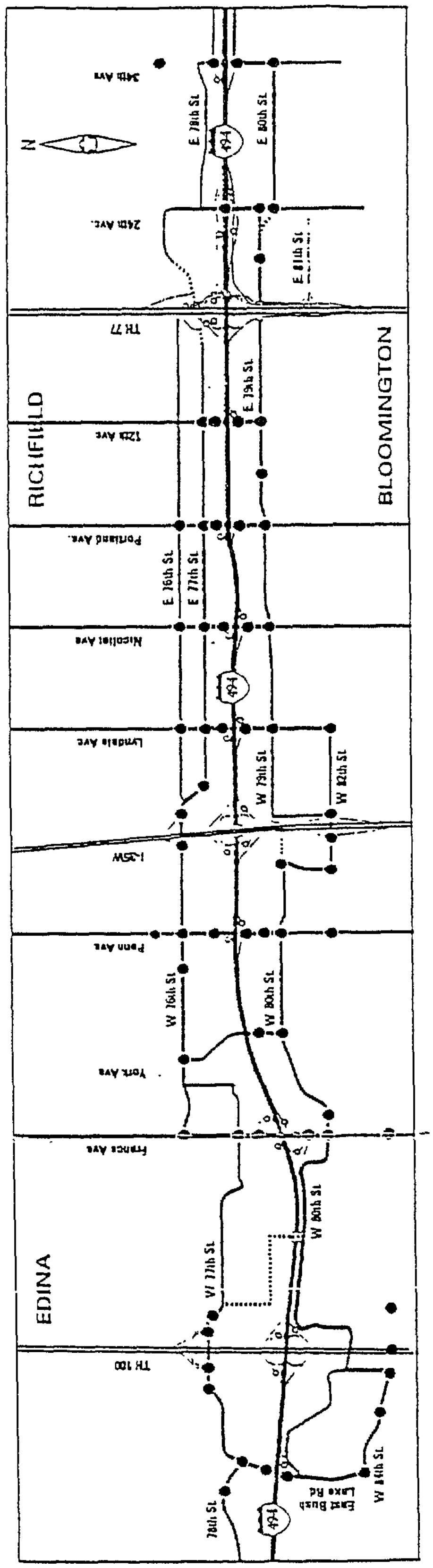
The Minnesota Department of Transportation in cooperation with Hennepin County and the cities of Bloomington, Edina and Richfield, is conducting a four-year phased operational test of an integrated corridor traffic management (ICTM) system. The test, as shown on Figure 1, involves an eight-mile-long congested segment of I-494 in the Twin Cities metropolitan area. In general, both freeway and arterial street traffic controls will be integrated with an adaptive control system that has the ability to continuously adjust arterial signals and freeway ramp meter traffic controls based on real-time traffic flow conditions within the study corridor. Additional elements of the test includes expanded incident management capabilities, the provision of real-time traffic information to motorists and route diversion guidance. The goal of the test is to improve the efficiency of traffic movement within the congested I-494 study corridor.

This interim report was prepared to document the evaluation analysis of the initial phased implementation of the ICTM operational test. More specifically, the ICTM project is being deployed in four modules. As shown in Figure 2, it was planned to have Modules 1 and 2 involve the implementation of adaptive traffic controls at 21 interchange ramp terminal signals and 27 ramp meters, along with the integration of the existing Freeway Management System (EMS) and Sydney Coordinated Traffic System (SCATS) software, as well as the installation of video imaging systems at four arterial intersections, and the development of operational plans and training. Module 3 involves implementation of adaptive controls at 41 arterial street intersections, and implementation of incident/special event management plans with portable traffic control devices, along with operational plan refinement and additional training. Module 4 includes video surveillance **on** the arterial street system, deployment of alternative route guidance signs on the arterial street system and refinement of incident/ special event management plans. Modules 1 and 2 were scheduled for implementation between January 1994 and November 1995, with Module 3 to be implemented between January and December 1996 and Module 4 to be implemented in 1997.

Due to roadway construction project schedules and adaptive control system communication problems, the implementation of adaptive controls at the 21 interchange ramp terminal signals was not completed in time for evaluation in this interim report. Therefore, this interim report presents the evaluation findings of the integration of 27 ramp meter signals along I-494 with an adaptive traffic control system. The evaluation of adaptive control on the arterial street system in the study corridor will be reported in a following interim report for Module 3.

Based on the ICTM Evaluation Design Plan prepared for the test, a total of eight detailed individual evaluation test plans (IETPs) have been designed to evaluate the effectiveness of ICTM in the I-494 corridor. The test plans address: 1) traflic volume, safety and operating efficiency parameters such as travel speeds, intersection delays, backups and cycle failures during peak and off-peak time periods on both the arterial and freeway systems; 2) adaptive control system capabilities; 3) impact on corridor motorists, residents and businesses and their travel pattern decisions; 4) Iegal or institutional issues identified during project deployment;

Figure 1
ICTM Project Area
494 Transportation Corridor



Project Elements
- ● Traffic Signals
- o Ramp Meters

Legend

Route Network
- Primary Project Routes
- Secondary Project Routes
- Future Routes
- Other Corridor Routes

Eastbound Zone
4D East Bush Lake Rd. to France Ave.
4E France Ave. to TH77
4F TH77 to 34th Ave.

Westbound Zone
4G 34th Ave. to I-35W
4H I-35W to East Bush Lake Rd.

Figure 2. ICTM Deployment Plan

1994 Module 1	1995: Module 2	1996: Module 3	1997: Module 4	1998
• System Hardware and Software • 21 Traffic Signals • Video Detection at 4 Sites - Develop Communication Plan	• System Jntegration • 27 Ramp Meters • Develop Operation Plan • Training	- 41 Traffic Signals • 11 CCTV on Arterial System • 2 VMS Freeway • Training - Communication Network	- Motorist Information Devices • Implement Operation Plan - Refine Incident/ Special Event Plan	
		Evaluation Plan		
• Develop Evaluation Plan	• Develop Evaluation Design	• Data Collection • Interim Report 1	• Data Collection • Interim Report 2	• Data Collection • Final Report

and 5) cost of system deployment. A detailed description of each test plan and data analysis is included in the following sections of this report. A summary of the Data Management Plan prepared for the IETPs is summarized in the appendix to this report.

This interim report is organized into five chapters and an appendix. Chapter I, "Introduction" describes the study purpose and scope; Chapter II, "Test Plan Descriptions" describes the content of the eight IETPs developed to evaluate the impact of each ICTM module, data collection/analysis activities conducted to date and any outside influences that may have impacted that data; Chapter III, "System Considerations" describes how the different data elements and evaluation measures of effectiveness (MOEs) are related to determine their net cumulative affect on traffic efficiency in the I-494 corridor; Chapter IV, "Results" presents the findings of before/after data evaluation collected for Modules 1 and 2; and Chapter V, "Conclusions" summarizes the system impacts identified from implementation of ICTM Modules 1 and 2. In addition to Chapters I through V, this report includes an appendix that contains detailed data summaries and statistical evaluation or documentation for each IETP.

II. Test Plan Descriptions

In order to evaluate the effectiveness of each of the Modules implemented in the ICTM project, eight Test Plans were developed to provide guidance in the evaluation process. Each of the test plans has a unique purpose and addresses one or more of the National ITS Goals. The following test plans have been prepared for evaluation of the ECTM operational test:

1. Change in Traffic Utilization of Transportation System in Corridor
2. Change in Corridor Operating Conditions
3. Ability of Adaptive Control System to Implement Alternative Traffic Control Plans
4. Change in Corridor Safety Parameters
5. Project Cost and System Deployment
6. Value to Agencies
7. Impact on Corridor Motorists, Residents, and Businesses
8. Legal and Institutional Issues

The following provides a brief description of each test plan, a summary of activities conducted for each test plan, and any outside influences that could impact data collected for each test plan. The bold text in each test plan MOE description indicates those measures where before/after data is available to evaluate impacts from project deployment to date.

Test Plan #l - Change in Traffic Utilization of Transportation System in Corridor

- *Test Description*

The purpose of Test Plan #l is to determine how well the ICTM system improves the use of available corridor system capacity. The test includes a comparison of freeway and arterial street traffic volume levels and its distribution passing through the study corridor at selected "screenline" locations before ICTM implementation to traffic volume levels and its distribution after implementation of each ICTM Module. Effectiveness is measured by the change in screenline traffic volume levels and distribution during periods of normal, recurrent freeway traffic congestion and periods affected by freeway system incidents. The following test activities are used to evaluate the related ICTM goals, objectives, and MOEs. The MOEs in bold text are addressed within this interim report.

Test Activity	Goal Addressed	Objectives Addressed	MOEs Addressed
Traffic Volume Collection	1. Determine if ICTM will respond to fluctuations in traffic flow, provide a safe driving environment, and facilitate the use of available capacity.	1-1 Determine the effectiveness of ICTM in improving traflic flow while making use of available transportation infrastructure in the corridor.	1-1.1 Increase in screenline traffic volumes during periods of recurrent traffic congestion.
Freeway Incident Data		1-3 Determine the effectiveness of the ICTM system for normal and incident traffic management.	I-3.1 Increase in screenline traffic volumes in response to incidetns traffic management plans.

- *National ITS Goals Addressed*

Goal 2 - Increase the operational efficiency and capacity of the surface transportation system.
Goal 5 - Enhance the personal mobility and the convenience and comfort of the surface transportation system.

- *Activities Performed*

Traffic volume data was collected at two screenline locations before and after implementation of Modules 1 and 2. Screenlines are located east of Nicollet Avenue and east of Xerxes Avenue. The before data includes a one week sample of hourly volumes on 79th Street, I-494, 77th Street, and 76th Street at the Nicollet Avenue Screenline and on 80th Street, I-494, and 76th Street at the Xerxes Avenue Screenline. Before data was collected during the August 14 to September 15, 1995 time period. After Modules 1 and 2 data was collected during the April 8 to May 10, 1996 time period. Adjustments were made to mid-day and Saturday traffic volumes observed during the 11:00 AM to 2:00 PM time period to account for seasonal variations in traffic flow. Peak period volumes were not adjusted based on the constant traffic patterns exhibited by commuters during these time periods.

Screenline traffic volume levels and distribution changes caused by freeway incidents was not addressed in this element of the operational test (MOE l-3.1). That element of the evaluation will rely on the implementation of incident management strategies implemented in ICTM Module 4. The TMC Incident Log was reviewed for each day in which screenline traffic volume data was collected. Traffic volume samples affected by freeway incidents were identified and removed from the analysis of screenline volumes during periods of recurrent traffic congestion (MOE l- 1.1).

Test Plan #2 - Change in Corridor Operating Conditions

- *Test Description*

The purpose of Test Plan #2 is to determine how well the ICTM system responds to fluctuations in traffic flow and facilitates the use of available corridor capacity. This test involves a “before/after” system implementation comparison sample analysis of travel time, ramp meter queue delay, intersection cycle failure and queue delays. The following test activities are conducted to evaluate the related ICTM goals, objectives, and MOEs. The MOEs in bold text are addressed within this interim report.

Test Activity	Goal Addressed	Objectives Addressed	MOEs Addressed
Travel Time Studies	1. Determine if ICTM will respond to fluctuations in traffic flow, provide a safe driving environment and facilitate the use of available capacity.	1-1 Determine the effectiveness of ICTM in improving traffic flow while making use of available transportation infrastructure in the corridor.	1-1.2 Decrease in travel time through the corridor. 1-1.3 Reduction in the number of arterial vehicle stops and delay within the corridor.
Ramp Meter Queue Studies Ramp Meter Timing Plan Documentation	1. Determine if ICTM will respond to fluctuations in traffic flow, provide a safe driving environment. and facilitate the use of available capacity.	1-1 Determine the effectiveness of ICTM in improving traffic flow while making use of available transportation infrastructure in the corridor. 1-2 Determine the effectiveness of ramp meter and ramp terminal interfaces.	1-1.4 Reduction in queue delays on freeway entrance ramps.
Intersection Queue/ Cycle Failure Studies and Turning Movement Counts Traffic Signal Timing Plan Documentation	1. Determine if ICTM will respond to fluctuations in traffic flow, provide a safe driving environment, and facilitate the use of available capacity.	1-1 Determine the effectiveness of ICTM in improving traffic flow while making use of available transportation infrastructure in the corridor. 1-2 Determine the effectiveness of ramp meter and ramp terminal interfaces.	1-1.5 Reduction in queue lengths and delays at arterial intersections. 1-2.1 Reduction in the number of cycle failures at arterial and ramp terminal intersections.

- *National ITS Goals Addressed*

Goal 2 - Increase the operational efficiency and capacity of the surface transportation system.
Goal 4 - Enhance present and future productivity.
Goal 5 - Enhance the personal mobility and the convenience and comfort of the surface transportation system.

- *Activities Performed*

1. Travel Time Studies were conducted on the following routes: Penn Avenue, France Avenue, Lyndale Avenue, Nicollet Avenue, Portland Avenue, 12th Avenue, 24th Avenue, 76th Street, 77th Street, 79th Street, 80th/82nd Street, and I-494. Ten runs were completed on each of the twelve routes during the AM Peak Period, Weekday Midday Period, PM Peak Period, and Saturday Midday Period for before and after Modules 1 and 2. Before data samples were collected between February 1994 and November 1995. After implementation of Modules 1 and 2 data samples were collected in April and May of 1996.

2. Freeway Ramp Oueue Studies were conducted at the following ramp meter locations: I-494 EB; France Ave NB, Penn Ave, Lyndale Ave, 12th Ave and I-494 WB; 24th Ave, Lyndale Ave, Penn Ave, France Ave SB. A one-day sample of "before" ramp queue lengths was collected during a one-hour time period for the AM and PM peak periods in August 1995. A one-day sample of "after" ramp queue lengths was collected during a two-hour time period for both the AM and PM peak periods in April and May of 1996.

Freeway on-ramp meter operating rate and traffic volume data was also collected for corresponding study periods.

3. Intersection Queue Studies were conducted at the following intersections: France Ave & 80th St., Penn Ave & 76th St., Penn Ave & I-494 South Ramp, Penn Ave & 80th St., Lyndale Ave & I-494 North Ramp, Lyndale Ave & 79th St. A one-day sample of "before" intersection queue lengths was collected during a one-hour time period for the AM peak, weekday midday, PM peak, and Saturday midday periods in August of 1995. A one-day sample of "after" intersection queue lengths was collected during a two-hour time period for the AM peak, weekday midday, and PM peak periods in April and May of 1996. Turning movement count data was also collected at sample intersections in April and May of 1996. The signal integration components of Modules 1 and 2 did not directly effect the arterial intersection operation due to implementation delays and communication problems. Therefore, all intersection study data collected to date will be used as baseline data for the evaluation of ICTM Module 3.

Test Plan #3 - Ability of an Adaptive Control System to Implement Alternative Traffic Control Plans.

- *Test Description*

The purpose of Test Plan #3 is to determine the effectiveness of an adaptive control system to manage traffic during normal (recurrent congestion) conditions as well as during traffic fluctuations caused by incidents. This test involves an analysis of ICTM system operator perceptions of the adaptive control system timing plans during normal and incident traffic conditions. Specifically, operator perceptions of the effectiveness of the adaptive control system to implement timing plans in response to fluctuations in traffic flow will be evaluated. The test also assesses the promptness of the adaptive control system to implement timing plans to changing traffic flow conditions and the coherence of transitions between different timing plans and integration of freeway / arterial street system operation. The following test activity will be used to evaluate the related ICTM goals, objectives, and MOEs.

Test Activity	Goal Addressed	Objective Addressed	MOEs Addressed
Operator Interviews/ Surveys	1. Determine if ICTM will respond to fluctuations in traffic flow, provide a safe driving environment, and facilitates the use of available capacity.	1-3 Determine the effectiveness of the ICTM system for normal and incident traffic management.	1-3.2 Operator's perception of adaptive control system timing plan implementation and transition under normal conditions. 1-3.3 Operator's perception of adaptive control system timing plan implementation and transition under incident/special event conditions.

- *National ITS Goals Addressed*

Goal 2 - Increase the operational efficiency and capacity of the surface transportation system.
Goal 4 - Enhance present and future productivity.
Goal 5 - Enhance the personal mobility and the convenience and comfort of the surface transportation system.

- *Activities Performed*

There were no activities performed to address this test plan since the adaptive control at arterial traffic signals were not operational until the Fall of 1996. Operator interviews will. be conducted as part of the evaluation of Module 3 and Module 4.

Test Plan #4 - Change in Corridor Safety Parameters

- *Test Description*

The purpose of Test Plan #4 is to determine the effectiveness of the ICTM project to increase corridor safety by reducing arterial and freeway accidents. The following test activities will be used to evaluate the related ICTM goals, objectives, and MOEs. The MOEs in bold text are addressed within this interim report.

Test Activity	Goal Addressed	Objectives Addressed	MOEs Addressed
Travel Time Studies	1. Determine if ICTM will respond to fluctuations in traffic flow, provide a safe driving environment and facilitate the use of available capacity.	14 Determine the effect of ICTM on corridor safety.	**14.1 Reduction in speed fluctuations along** the **freeway attributed to ICTM.**
Mn/DOT **Accident (TIS)** Database	1. Determine if **ICTM will** respond to fluctuations in traffic flow, provide a safe driving environment and facilitate the use of available capacity.	14 Determine the effect of ICTM on corridor safety.	14.2 Reduction in freeway/arterial accident frequencies and severity.

- *National ITS Goals Addressed*

Goal 1 - Improve the safety of the nation's surface transportation system.
Goal 2 - Increase the operational efficiency and capacity of the surface transportation system.
Goal 5 - Enhance the personal mobility and the convenience and comfort of the surface transportation system.

- *Activities Performed*

1. Freeway Speed Fluctuation data was collected from travel time studies on the freeway system as described in Test Plan 2. Ten runs were conducted in each direction on I-494 during the AM and PM peak periods. "Before" data samples were collected in May of 1994, and "after" data samples were collected in the April/May 1996 time period.

2. Accident Data on the freeway and arterial street system within the study corridor was summarized for the year of 1994. The 1994 data will be used as baseline data in the evaluation of ICTM Module 4. No impact on traffic safety is included as part of this interim report.

Test Plan #5 - Project Cost and System Deployment

- *Test Description*

The purpose of Test Plan #5 is to identify the cost of the ICTM operational test, the cost of system expansion within the I-494 test corridor, and the expandability and transferability of ICTM to other corridors. This test plan involves the documentation of all costs associated with the ICTM operational test and estimates the costs associated with continued use and expansion after the test. The evaluation relies on documentation of all capital, equipment, installation, maintenance, training, and operating costs of the ICTM system components as well as all contributions from participants involved in the project. The costs associated with the operational test will be used to project costs of continued and expanded use. The following test activities are conducted to evaluate the related ICTM goals, objectives, and MOEs. The MOEs in bold text are addressed within this interim report.

Test Activity	Goal Addressed	Objectives Addressed	MOEs Addfessed
Review of ICTM **Documents** Meet with ICTM Project Manager Interview & Discussion Groups with Front-line Operations Managers	5. Determine the expandability and transferability of ICTM.	5-1 Document current costs of the operational test	5-1.1 Document all fixed and on-going costs. 5-1.2 Document public/private sector contributions.
		5-2 Estimate the cost of system expansion within the existing participating jurisdictional boundaries.	5-2.1 Document required infrastructure improvements and costs for expansion in implementation plan.
		5-3 Document the conditions and costs of deploying the system in another congested corridor	5-3.1 Document the base conditions which warrant the ICTM concept for another corridor. 5-3.2 Document core infrastructure required to incorporate ICTM system. **5-3.3 Document variable and on-going costs** for **deployment in another corridor.** 5-3.4 Document critical issues and procedures needed for implementation of ICTM concept. 5-3.5 Document lessons learned in deploying the ICTM system.

- *National ITS Goal Addressed*

Goal 6 - Create an environment in which the development and deployment of ITS can flourish.

- *Activities Performed*

The evaluation contractor has reviewed ICTM cost and contribution records. All costs encountered thus far in the operational test have been documented and summarized for deployment of Modules 1 and 2. Public and private partner soft and hard contributions have also been documented. The expandability issues identified in interviews with front-line operation managers will be reported in the evaluation of Module 3 and Module 4.

Test Plan #6 - Value to Agencies

- *Test Description*

The purpose **of** Test Plan #6 is to determine the value of ICTM to participating transportation agencies. The evaluation assesses agency perceptions of the effectiveness of ICTM to manage corridor traffic, meet the needs of participating agencies, operate corridor traffic control via adaptive control, and assess the effects of ICTM on the transportation system. The evaluation relies on interviews and discussion groups with key agency personnel. The following test activities will be conducted to evaluate the related ICTM goals, objectives, and MOEs.

Test Activities	Goal Addressed	Objectives Addressed	MOEs Addressed
Agency Front-Line Managers Interviews/Discussion Groups	1. Determine if ICTM will respond to fluctuations in traffic flow, provide a safe driving environment, and facilitate the use of available capacity.	1-3 Determine the effectiveness of the ICTM system for normal and incident management	1-3.5 -Agency perceived value of expanded traffic control and motorist information devices for normal and incident management.
Agency Operations Staff Interviews/ Discussion Groups Agency Operation Logs	2. Determine how well multiple transportation agencies can work together to manage a congested leeway.	2-1 Determine the extent that corridor-wide traffic management principles meet agency needs and expectations. 2-2 Determine to what extent inter-jurisdictional operations and maintenance strategies meet agency needs. 2-3 Assess the individual agency's perceptions of the value of integrated corridor traffic management 2-4 Determine if current or planned arterial capital improvements can be modified to accommodate ICTM.	2-1.1 Document conditions when agencies did not conform to corridor-wide principles. 2-1.2 Traffic managers perceived added value of corridor-wide traffic management principles. 2-2.1 Agency perceived benefits of inter-jurisdictional operations and maintenance strategies. 2-2.2 Document the impacts of inter-jurisdictional operations and maintenance on agency staffing requirements, workload, and costs. 2-3.1 Agency perceived added value of multiple agencies working together. 2-3.2 Agency perceived improvement in corridor operations compared to current operations. 2-3.3 Agency perceived usefulness of surveillance components for operation purposes. 2-4.1 Agency perceived added value of modified capital improvement projects.
	3. Determine if available advanced technology tools are capable of facilitating corridor traffic management and the collection and dissemination of corridor information between agencies.	3-1 Determine if an adaptive control system is effective in monitoring corridor-wide traffic conditions.	3-1.1 Agency's perception of the SCATS system accessibility. 3-1.2 Agency's perception of the communication network reliability. 3-1.3 Agency's perception of ICTM training and support. 3-1.4 Document mean time between SCATS system failures. 3-1.5 Agency's perception of ability to manage corridor operations via SCATS. 3-1.6 Document SCATS system operational limitations and restrictions. 3-1.7 Agency perceived usefulness of system data to support maintenance needs and operational analysis.
	6. Evaluate transportation system impacts,	6-2 Assess the affects of ICTM on traffic control systems bordering the corridor.	6-2.1 Agency's perception of ICTM impact on freeway and arterial traffic operations bordering the operational test area

- *National ITS Goals Addressed*

Goal 2 - Increase the operational efficiency and capacity of the surface transportation system.

Goal 6 - Create an environment in which the development and deployment of ITS can flourish.

- *Activities Performed*

There were no activities performed to address this test plan. Agency interviews, discussion groups, and user logs will be conducted as part of the evaluation of Module 3 and Module 4.

Test Plan #7 - Impact on Corridor Motorists, Residents and Businesses

- *Test Description*

The purpose of Test Plan #7 is to assess the public perception of traffic conditions and travel patterns before and after the implementation of ICTM principles. The evaluation assesses corridor residents', motorists', and business manager's perceptions of changes in traffic conditions directly attributed to the ICTM operational test. The following test activities will be used to evaluate the related ICTM goals, objectives, and MOEs.

Test Activity	Goal Addressed	Objectives Addressed	MOEs Addressed
Corridor Motorists Telephone Survey Corridor Resident Focus Group	4. Determine the usefulness of traffic control strategies, public relations plan, and motorist information to the motorists.	4-1 Determine if the provided corridor traffic information is sufficient for the motorist to make informed decisions on route choices. 4-2 Assess motorist perceptions of the effectiveness of ICTM. 4-3 Assess the effectiveness of the ICTM public relations plan.	4-1.1 Motorist's perception of ICTM information (clarity, accuracy, timeliness). 4- 1.2 Change in travel patterns attributed to corridor traffic information. 4-2.1 Change in motorist's attitude in route selection for all trips. 4-2.2 Motorist perceived improvement in corridor traffic operations attributed to ICTM. 4-3.1 Motorist perceived awareness of project. 4-3.2 Motorist perceived support for the project based on the information presented.
Corridor Business Operator Focus Group	6. Evaluate transportation system impacts.	6-3 Assess the effects of ICTM on the residential and business communities within the corridor.	6-3.1 Corridor residents and businesses perceived changes in traffic conditions (safety, volume, operating conditions). 6-3.2 Corridor residents and businesses perceived value of ICTM project improvements.

- *National ITS Goals Addressed*

Goal 2 - Increase the operational efficiency and capacity of the surface transportation system.
Goal 4 - Enhance present and future productivity.
Goal 5 - Enhance the personal mobility and the convenience and comfort of the surface transportation system.
Goal 6 - Create an environment in which the development and deployment of ITS can flourish.

- *Activities Performed*

1. A Motorist Telephone Survey was completed in the April/May 1996 time period. MarketLine Research, Inc. completed the baseline telephone survey of 383 corridor motorists. The summarized baseline data will be compared to "after" ICTM survey data scheduled to be collected in the spring of 1998.
2. A Resident Focus Group session was conducted on April 10, 1996. PowerMax Consulting conducted and summarized baseline resident focus group comments from five residents living within the ICTM corridor. The summarized baseline data will be compared to "after" ICTM focus group data scheduled to be collected in the spring of 1998.

3. A Business Onerator Focus Group session was conducted on April 11, 1996. PowerMax Consulting conducted and summarized baseline business operator focus group comments from six managers/operators of businesses within the ICTM corridor. The summarized baseline data will be compared to "after" ICTM focus group data scheduled to be collected in the spring of 1998.

Test Plan #8 - Legal and Institutional Issues

- *Test Description*

The purpose of Test Plan #8 is to document all issues encountered during the ICTM Operational Test including resolutions to issues and impact on agency policies, procedures and agreements. This test involves documenting all multi-agency agreements, legal and institutional issues which have been encountered during the implementation of ICTM. In addition, resolutions to these issues and policies and procedures which have been altered will also be documented. The following test activities are conducted to evaluate the related ICTM goals, objectives, and MOEs. The MOEs in bold text are addressed within this interim report.

Test Activity	Goal Addressed	Objective Addressed	MOEs Addressed
Review of ICTM Documents Interviews/Discussion Groups with Front-Line Operations Managers	5. Determine the expandability and transferability of ICTM.	5-4 Determine the impact of legal and institutional issues.	5-4.1 Document all multi-agency agreements. 5-4.2 Document all legal OF institutional issues encountered and the resolutions to those resolved. 5-4.3 Document policies or procedures altered due to ICTM

- *National ITS Goal Addressed*

Goal 6 - Create an environment in which the development and deployment of ITS can flourish.

- *Activities Performed*

The evaluation contractor has reviewed ICTM documents including the Operational Test Proposal, the Implementation Plan, the Maintenance Plan, Federal Quarterly Progress Reports, and minutes from the ICTM Management Team, Operations Committee, and Evaluation Committee meetings.. All legal and institutional issues encountered thus far in deployment of the operational test have been documented and summarized. Public and private partner agreements and policies have also been documented. The legal and institutional issues identified in interviews with front-line operation managers will be reported as part of the evaluation of Module 3 and Module 4.

Outside Influences

Influential activities occurring within the study corridor beyond the control of the operational test, could involve roadway construction activities, labor strikes, extreme weather conditions, retail and commercial development, operational test complications, and freeway incidents. The following summarizes those activities identified during this first phase of the ICTM operational test:

a. Construction Activities occurring during traffic data collection for the evaluation of Modules 1 and 2 include the following:

- 77th Street - Road reconstruction between Lyndale and Cedar Avenues completed October 1995.
- 76th Street ramp to NB I-35W was closed from April 15 until mid-July1996
- 76th Street bridge over I-35W was reduced to a single lane in both directions from April 29 until May 22, 1996

- I-494 EB had a restricted 45 mph speed limit on the bridge over I-35W from April 15 until September 23, 1996
- 79th Street at Lyndale Avenue, unscheduled gas line work, 79th Street reduced to a single lane on May 7, 1996

It appears that the principle change in facility usage from roadway construction activities occurred on the improved segment of 77th Street, which attracted traffic from parallel arterial streets, particularly 76th Street andpotentially some trips from I-494.

b. Labor Strikes occurring during the operational test include the following:

- Metropolitan Council Transit Operation, October 1995

Data collection occurred before and after the strike and should not have been greatly impacted by the temporarily increased automobile dependency that may have occurred during the strike.

c. Retail and Commercial Develooment occurring during the implementation of Modules 1 and 2 include the following:

- Shops of Lyndale at Lyndale Ave and 77th Street
  - Phase 1 opened November 1995, included 117,000 sq. ft of retail including a Best Buy and Sport Mart superstores
  - Phase 2 opened October 1995, included 114,000 sq. ft of retail including a Land's End Outlet, Petsmart, and Baby Superstore
- Walmart discount store opened 160,000 sq. ft store at 79th Street and Chicago Avenue in January 1995.
- Southtown Shopping Center at Penn Avenue and 79th Street expanded 120,000 sq. ft of retail shops including Kohl's Department Store throughout 1995 and 1996.
- Circuit City electronic superstore opened 116,000 sq. ft of retail at 78th Street and Johnson Avenue in January 1995.
- Seagate Technologies expanded 225,000 sq. ft of industrial at 78th Street and Computer Avenue in September 1996.

According to trip generation data published by the Institute of Transportation Engineers, this new development could be expected to generate up to the following number of additional trips in the study corridor:

Weekday	*19,500 trips per day*
A.M. Peak Hour	*600 trips per hour*
P.M. Peak Hour	*1,800 trips per hour*
Saturday	*22,000 trips per day*

This trip growth in the study corridor would be distributed over the entire transportation system network. Corrections were not made to adjust the conclusions identified in this interim evaluation but are noted in traffic volume changes across the corridor screenlines.

d. ICTM Operational Test Complications directly affecting the collection of traffic data included:

- Adaptive Control System communication failure, no adaptive control week of April 22, 1996

Evaluation data was not collected during the week of April 22, 1996.

e. Freewav Incidents

Baseline freeway and arterial traffic operating condition data was collected during the fall of 1995 as shown below. Comparative after module 1 and 2 data was collected in the spring of 1996 as also shown below:

Data Type	Before (1995)	After (1996)
1. Screenline Volumes	August 8 - September 18	April 8-20 & May 6-l 1
2. Travel Times	February - May August - November	April/May
3. Ramp Queue / Delay	August	April/May
4. Intersection Queue / Delay	August	April/May

1. A total of seven freeway-related incidents were reported during the “before” baseline data collection time period that could have impacted the evaluation of traffic operating conditions data:

- Incidents within ICTM Corridor during AM Peak Period
  - 5/3 l/94, 7:45-7:47 - I-494 WB at France Ave, 4-car accident in left lane
  - 5/3 l/94, 8: 19-8:26 - I-494 WB at Nicollet Ave, stalled vehicle in left lane
  - 8/17/95, 8:06-8:26- I-494 WB at Lyndale Ave, stalled vehicle in center lane
- Incidents within ICTM Corridor during PM Peak Period
  - 5/26/94 18:02-l 8: 50 - I-494 EB at France Ave, vehicle in left lane
- Incidents within ICTM Corridor during Midday or Off-Peak Periods
  - 8/14/95 1, 6:00-l 6:22 - I-494 EB at Nicollet Ave, stalled vehicle blocking left lane/shoulder.
  - 8/16/95, 12:53-1:25- I-494 WB at Lyndale Ave, stalled truck blocking right lane/shoulder.

2. A total of eight freeway-related incidents were reported during the "after" data collection time period that could impact the evaluation of traffic operating condition data:

- Incidents within ICTM Corridor during AM Peak Period
  - None identified
- Incidents within ICTM Corridor during PM Peak Period
  - 4/12/96, 14:55-15:31 - I-494 WB at I-35W, 2-car accident in right lane
  - 4/l 5/96, 17: 15-17:46 - I-494 WB at Lyndale Ave, 3-car accident in left lane
  - 4/19/96, 15: 15-15:35 - I-494 EB at Lyndale Ave, 3-car accident in center lane
  - 5/6/96, 16: 1 l-l 6:37 - I-494 WB at Lyndale Ave, 1 stalled car in left lane
  - 5/7/96, 15:07-16:34 - I-494 EB at TH 100, 3-car accident in right shoulder
- Incidents within ICTM Corridor during Midday or Off-Peak Periods
  - 4/16/96, 13:06-13:3 1 - I-494 EB at TH 100, 2-car accident in center lane
  - 5/6/96, 19:20- 19:45 - I-494 EB at TH 100, l-car accident in right shoulder
- Incidents Outside ICTM Corridor
  - 5/14/96 - I-494 EB and WB at US 6 1, closed for accident, ten miles east of corridor

To ensure that the data evaluation was not impacted by the above incidents, traffic operating condition data collected during these incident time periods was not used in the evaluation.

III. System Considerations

The eight IETPs developed for evaluation of the ICTM project, previously described in the report, identified a total of 47 measures of effectiveness or documentation issues that need to be addressed. To accurately assess the impacts of ICTM in the I-494 corridor, a set of comprehensive data sources were identified. The data sources include quantitative traffic engineering measurements, agency and public perceptions, documented system performance issues and project implementation costs. Many of these data sources intentionally overlap each other to confirm or support system conclusions. A general description of each data source is described below:

- Quantitative data sources include comparative measurements of before/after freeway and arterial traffic operating conditions, such as changes in screenline traflic volumes; travel time, speed, and delay, intersection and freeway entrance ramp queue delays; and corridor accidents. Quantitative data are established based on direct field measurements and/or computations of traffic operating conditions.

- Agency Perceotions on corridor operations due to ICTM will be collected from discussion groups, interviews, and participating agency logs. Specifically, the agencies will provide insight to the value of adaptive traffic control effectiveness, surveillance components, modified capital improvement projects, inter-jurisdictional operations/ maintenance, and ICTM training/support.

- Public Perceptions will be collected from discussion groups with corridor residents and business managers as well as through telephone surveys of corridor motorists. The discussion groups and telephone surveys will inquire public perceptions on changes in corridor operating conditions, usefulness of ICTM motorist information, and changes in travel patterns and route selection.

- Documentation of Svstem Performance Issues will be collected through agency logs/interviews and review of ICTM documents. Information gathered will be used to identify adaptive control system limitations, restrictions, and failures; impacts of inter-jurisdictional operations/maintenance on agency staffing/workload; policies, procedures and agreements established/altered; legal and institutional issues encountered and their resolution.

- Documentation of Svstem Costs will be collected to identify unit costs associated with ICTM components that can be used to estimate the cost of system expansion or deployment in another community: Costs will be documented through review with the ICTM Project Manager cost and contribution records.

In order to apply these different data sources to a system-wide evaluation analysis, it is necessary to identify the inter-relationship between different data sources and each MOE or documentation issues addressed in the eight IETPs. Keeping in mind that the basic goal of ICTM is to improve the efficiency of traffic movement in the congested I-494 corridor using the existing infrastructure and advanced technologies, the IETPs can be bundled into the following five basic evaluation areas:

1. Ability of ICTM to manage corridor traffic conditions during both normal and freeway incident time periods;
2. Ability of ICTM to implement an effective motorist information program;
3. Impact of ICTM on bordering traffic control systems;
4. Ability of ICTM to make use of available transportation infrastructure and its expandability or transferability to another area; and
5. Ability of multiple transportation agencies to work together and manage traffic in a congested freeway corridor.

A description of the data source, the test plan and measures of effectiveness related to each of the above evaluation areas is summarized on the following tables. All MOEs that have before/after data comparisons are indicated in **bold** type. MOEs that have documented before condition data only are indicated with an asterisk (*):

- EVALUATION AREA 1: Ability of ICTM to manage corridor traffic conditions during both normal and freeway incident time periods.

Data Sources	Test Plans	Measures of Effectiveness
Quantitative	Test Plan 1	1-3.1 - Increase in screenline traffic volumes in response to incident management plans.
	Test Plan 2	**l-l.2 - Decrease in travel time through the corridor.** l-l.3 - Reduction in the number of arterial vehicle stops and delay within the corridor.* 1-1.4 - Reduction in queue delays at freeway entrance ramp meters. 1-1.5 - Reduction in queue delays at arterial intersections.* 1-2.1- Reduction in the number of cycle failures at arterial and ramp terminal intersections.*
	Test Plan 4	**l-4.1- Reduction in speed fluctuations along the freeway attributed to ICTM.** l-4.2 - Reduction in freeway/arterial accident frequency and severity.*
Agency Perception	Test Plan 3	l-3.2 - Operator's perception of adaptive control timing plan implementation and transition under normal conditions. l-3.3 - Operator's perception of adaptive control timing plan implementation and transition under incident conditions.
	Test Plan 6	l-3.5 - Agency perceived value of expanded traffic control and motorist information devices for normal and incident management. 2-1.2 - Traffic managers and operators perceived added value of corridor-wide traffic management principles. 2-3.2 - Agency perceived change in corridor operations compared to current operations. 2-3.3 - Agency perceived usefulness of surveillance components for operation purposes. 2-4.1 - Agency perceived added value of modied capital improvement projects. 3-1.1 - Agency's perception of the adaptive control system accessibility. 3-1.2 - Agency's perception of the communication network reliability. 3-1.3 - Agency's perception of ICTM training and support 3-1.5 - Agency's perception of ability to manage corridor operations via adaptive control. 3-1.7 - Agency perceived usefulness ofsystem data to support maintenance and operational analysis.
Public Perception	Test Plan 7	4- 1.1 - ,Motorist's perception of ICTM information (clarity, accuracy, timeliness).* 41.2 - Change in travel patterns attributed to corridor traffic information.* 4-2.2- Motorist perceived improvement in corridor operations attributed to ICTM.* 6-3. 1 - Corridor residents and businesses perceived changes in traffic conditions (safety, volume, operating conditions).* 6-3.2 - Corridor residents and businesses perceived value of ICTM project improvements.*
Performance Issues	Test Plan 6	3-1.4 - Document mean time between adaptive system failures. 3-1.6 - Document adaptive contro1 system operational limitations and restrictions.

- EVALUATION AREA 2: Ability of ICTM to implement an effective motorist information program.

Data Sources	Test Plans	Measures of Effectiveness
Agency Perception	Test Plan 6	1-3.5 - Agency perceived value of expanded traffic control and motorist information devices for normal and incident management.
Public Perception	Test Plan 7	4-1.1 - Motorist's perception of ICTM information (clarity, accuracy, timeliness).* 4- 1.2 - Change in travel patterns attributed to traffic information. * 4-2.1 - Change in motorist's attitude in route selection for all trips.* 4-2.2 - Motorist perceived improvement in corridor operations attributed to ICTM.* 4-3.1- Motorist perceived awareness of the project.* 4-3.2- Motorist perceived support for the project based on the information presented.* 6-3.1 - Corridor residents and businesses perceived changes in traffic conditions (safety, volume, operating conditions).* 6-3.2 - Corridor residents and businesses perceived value of ICTM project improvements.*

- EVALUATION AREA 3: Impacts of ICTM on bordering traffic control systems.

Data Sources	Test Plans	Measures of Effectiveness
Agency Perception	Test Plan 6	2-1.2 - Traffic managers and operators perceived added value of corridor-wide traffic management principles. 2-3.2 - Agency perceived change in corridor operations compared to current operations. 2-3.3 - Agency perceived usefulness of surveiilance components for operation purposes. 6-2.1 - Agency's perception of ICTM impact on freeway and arterial traffic operations bordering the operational test area.
Public Perception	Test Plan 7	4-2.2 - Motorist perceived improvement in corridor operations attributed to ICTM* 6-3.1 - Corridor residents and businesses perceived changes in traffic conditions (safety, volume, operating conditions).* 6-3.2 - Corridor residents and businesses perceived value of ICTM project improvements.*
Performance Issues	Test Plan 6	2-1.1 - Document conditions when agencies did not comply to corridor-wide principles.

- EVALUATION AREA 4: Ability of ICTM to make use of available transportation infrastructure; and its expandability or transferability to another area.

Data Sources	Test Plans	Measures of Effectiveness
Quantitative	Test Plan 1	**l-1.1 - Increase in screenline traffic volumes during periods of recurrent traffic congestion.**
Agency Perception	Test Plan 6	2- 1.2 - Traffic managers and operators perceived added value of corridor-wide traffic management principles. 2-3.2 - Agency perceived change in corridor operations compared to current operations. 3-1.5 - Agency's perception of ability to manage corridor operations via adaptive control. 3-1.7 - Agency perceived usefulness of system data to support maintenance and operational analysis.
Public Perception	Test Plan 7	4- 1.2 - Change in travel patterns attributed to traffic information.* 4-2.1 - Change in motorist's attitude in route selection for all trips.* 4-2.2 - Motorist perceived improvement in corridor operations attributed to ICTM.* 6-3.1 - Corridor residents and businesses perceived changes in traffic conditions (safety, volume, operating conditions).* 6-3.2 - Corridor residents and businesses perceived value of ICTM project improvements.*
Performance Issues	Test Plan 5	5-3.1 - Document the base conditions which warrant the ICTM concept for another corridor. 5-3.2 - Document core infrastructure required to incorporate the ICTM system. 5-3.4 - Document critical issues and procedures needed for implementation of ICTM concept 5-3.5 - Document lessons learned in deploying the ICTM system.
	Test Plan 8	**5-4.2- Document all legal and institutional issues encountered and the resolutions to those resolved.**
costs	Test Plan 5	**5-l.l- Document ail tied and on-going costs.** **5-l.2 - Document public/private sector contributions.** 5-2.1 - Document required infrastructure improvements and costs for expansion in implementation plan **5-3.3 - Document variable and on-going costs for deployment in another corridor.**

- EVALUATION AREA 5: Ability of multiple transportation agencies to work together and manage traffic in a congested freeway corridor.

Data Sources	Test Plans	Measures of Effectiveness
Agency Perception	Test Plan 6	2-2.1 - Agency perceived benefits of inter-jurisdictional operations and maintenance strategies. 2-3.1 - Agency perceived added value of multiple agencies working together.
Performance Issues	Test Plan 6	2-1.1- Document conditions when agencies did not comply to corridor-wide principles. 2-2.2 - Document the impacts of inter-jurisdictional operations and maintenance on agency staffing requirements, workload, and costs.
	Test Plan 8	**5-4.l- Document all multi-agency agreements.** **5-4.2 - Document all legal or institutional issues encountered and the resolutions to those resolved.** **5-4.3 - Document policies or procedures altered due to ICTM.**
Costs	Test Plan 5	**5-l.l- Document all fixed and on-going costs.** **5-1.2 - Document public/private sector contributions.**

As shown on these five evaluation area tables, the collection of before/after data has not been completed for a full assessment of ICTM deployment. The bold text in each table indicates those measures where before/after data is available to partially address MOEs in the eight different test plans. Text with an asterisk indicates baseline "before" data that has been collected for comparison with data collected after deployment of modules 3 and 4. The data available for before/after evaluation are contained in evaluation areas 1, 4 and 5, pertaining to the following ten MOEs:

l-l.1 Increase in screenline traffic volumes during periods of recurrent traffic congestion.

l-l .2 Decrease in travel time through the corridor.

l-l .4 Reduction in queue delays on freeway entrance ramps.

l-4.1 Reduction in speed fluctuations along the freeway attributed to ICTM.

5-l. 1 Document all fixed and on-gding costs.

5- 1.2 Document public/private sector contributions.

5-3.4 Document critical issues and procedures needed for implementation of ICTM concept.

5-4.1 Document all multi-agency agreements.

5-4.2 Document all legal or institutional issues encountered and the resolutions to those resolved.

5-4.3 Document policies or procedures altered due to ICTM.

Another 13 MOEs have "before" baseline data collection completed but not comparable at this date with future data collection efforts. The following results rely on the ten MOE's directly documenting before/after changes that may be attributable to ramp metering integration and supporting "before" only data, as well as project cost documentation for ICTM deployment to date.

IV. Results

The results of this interim evaluation are principally limited to reporting on the effectiveness of ramp meter integration with an adaptive traffic control system. The impact of this activity is not considered to have affected arterial operating conditions in the I-494 study corridor. The arterial street traffic control system integration was not operational in time for this evaluation and will not be reported until after the next data collection period of April - May 1997. Therefore, the results reported in this report will be focused on data collected for before/after on-ramp and freeway operating conditions.

This analysis will look at the collective system considerations set forth in the previous section of this report based on data collected to date. Many of thddetailed data summaries used to describe the results reported herein are contained in the Appendix to this report.

- **Evaluation Area 1:** Ability of ICTM to manage corridor traffic conditions during both normal and freeway incident time periods.

  a) TRAFFIC VOLUME PATTERNS: This evaluation area focuses on changes in the operational and traffic safety conditions of the transportation network in the study corridor. A critical element in the evaluation of "before/after" traffic conditions is a determination of changes in traffic volume. Screenline traffic data was collected at two locations in the I-494 corridor: east of Nicollet and Xerxes Avenues. The "before" ICTM traffic volume data was collected during the August/September 1995 time period. All other traffic data is scheduled to be collected during the April/May time period of each year to coincide with implementation of future ICTM module deployment. It was determined from the screenline data that corridor traffic level changes varied by time of day. As shown on Table 1 A, screenline "before/after" peak period traffic volume levels between 1995 and 1996 varied by +4.54 to -8.70 percent. Statistical tests indicate all but the 7:00 to 8:00 AM time period showed a significant reduction in freeway and corridor-wide traffic volume levels. Similarly, mid-day and Saturday traffic volume levels during the 11:00 AM to 2:00 PM time period demonstrated a corridor-wide reduction in traffic volume levels. Freeway volumes, however, did show a significant increase during the Saturday 11:00 AM to 2:00 PM time period. A review of the arterial system screenline data indicates that traffic on 77th Street has increased significantly during the study period by a range of +17.5 to +83.2 percent. This increase is attributed to the construction activity on 77th Street during the collection of "before" traffic data and the completed construction activity represented by the "after" traffic data. The "after" traffic data will be used as a baseline for future module deployment evaluation.

Table 1A: Average Peak Period Corridor-Wide Traffic Volumes

	AM Peak Period (6:00-9:00 am)			AM Peak Hour (7:00-8:00 am)		
	Before	After	% change	Before	After	% change
EB at Nicollet Ave	14,025	14,484	3.27%	5,394	5,639	4.54%
WB at Nicollet Ave	17,790	17,382	-2.29%	6,537	6,570	0.50%
EB at Xerxes Ave	17,249	17,060	-1.10%	6,549	6,565	0.24%
WB at Xerxes Ave	22,027	21,458	-2.58%	8,202	8,032	-2.07%
Total	71,091	70,384	-0.99%	26,682	26,806	0.46%
	PM Peak Period (3:00-6:00 pm)			PM Peak Hour (4:00-5:00 pm)		
	Before	After	% change	Before	After	% change
EB at Nicollet Ave	20,842	21,181	1.63%	7,305	7,423	1.62%
WB at Nicollet Ave	19,275	18,481	-4.12%	6,528	6,226	-4.63%
EB at Xerxes Ave	25,460	23,740	-6.76%	8,919	8,143	-8.70%
WB at Xerxes Ave	20,956	20,645	-1.48%	7,050	6,930	-1.70%
Total	86,533	84,047	-2.87%	29,802	28,722	-3.62%

Table 1B: Average Annual Midday/Saturday Corridor-Wide Traffic Volumes

	Weekday Midday (11:00 am-2:00 pm)			Saturday Midday (11:00 am-2:00 pm)		
	Before	After	% change	Before	After	% change
EB at Nicollet Ave	13,934	13,360	-4.12%	13,515	14,626	8.22%
WB at Nicollet Ave	14,699	13,784	-6.22%	14,272	13,676	-4.18%
Nicollet Total	28,633	27,144	-5.20%	27,787	28,302	1.85%
EB at Xerxes Ave	17,908	16,962	-5.28%	16,307	16,656	2.14%
WB at Xerxes Ave	16,562	16,570	0.05%	14,739	15,111	2.52%
Xerxes Total	34,470	33,532	-2.72%	31,046	31,767	2.32%
Total	63,103	60,676	-3.85%	58,833	60,069	2.10%

b) <u>FREEWAY TRAVEL SPEED DATA</u>: In addition to the collection of traffic volume screenline data, data was collected as part of IETP 2 on transportation network travel speeds and as part of IETP 4 on corridor accident conditions. For comparison purposes, traffic volume on the freeway system on those days when before/after travel speed data was collected increased by a range-of (+)2.88 to (+)7.15 percent in the east and westbound directions, respectively, during the morning 7:30 to 8:30 AM time period and by (+)4.73 to (+)4.26 percent during the evening 4:30 to 5:30 PM evening time period, as shown on Table 2. In comparison, as shown in Table 3, average 7:30 to 8:30 AM peak hour travel speeds in the eastbound direction decreased by (-)2.41 percent, and in the westbound direction increased by (+)42.37 percent. Speeds during the 4:30 to 5:30 PM peak hour increased by (+)9.91 and (+)11.85 percent in the east and westbound directions, respectively. As shown on

Figure 3, average travel speeds across freeway ramp meter zones on eastbound I-494 remained relatively constant except during the 7:30 to 8:30 AM peak hour between TH 77 and the Minnesota River which increased from a speed of 58.9 to 62.5 mph and during the 4:30 to 5:30 PM peak hour period on the I-494 segment between E. Bush Lake Road and Xerxes Avenue, where speeds were reduced from 39.0 to 36.1 mph. In comparison, westbound speeds in both ramp meter zones increased during the AM and PM peak hours.

An important element of travel speed conditions involves the consistency of speeds over time. As shown on Table 4, the range between eastbound minimum and maximum travel speeds was reduced by 4.26 percent during the 7:30 to 8:30 AM peak hour, and increased by 13.95 percent during the 4:30 to 5:30 PM peak hour. In comparison, the westbound speed range was reduced by 1.96 and 14.58 percent during both peak hour periods, respectively. According to data collected in IETP 7, corridor motorists have indicated they perceive trip times on I-494 to be relatively consistent or increasing during the year prior to implementation of ICTM. In fact, as shown above, ICTM has provided a measurable improvement in travel time consistency by reducing the range in travel speed in three out of four peak period cases.

c) ACCIDENT DATA: Speed consistency is considered an indirect measurement for traffic safety potential. A wide travel speed range is normally an indicator of higher accident conditions. A comparison of actual changes in freeway or corridor accident frequencies will be provided in the final ICTM evaluation report. For reference purposes, there were a total of 672 accidents reported on the study segment of I-494 in 1994, of which 75 percent involved property damage only. Of the 672 freeway accidents, 129 occurred during the morning peak period and 153 occurred during the evening peak period.

Table 2. Freeway Traffic Volume During Travel Speed Data Collection*

EASTBOUND						
7:30 to 8:30 AM Peak HOUR						
Before ICTM			After Mod. 1 and 2			% change in volume
Date	# of runs	Volume	Date	# of runs	Volume	
5/18/94	2	5,718	4/10/96	2	5,624	
5/26/94	2	5,218	4/11/96	2	5,672	
6/2/94	1	5,481	4/18/96	1	5,573	
Total/Avg	5	5,471	Total/Avg	5	5,633	2.88%

4:30 to 5:30 PM Peak HOUR						
Before ICTM			After Mod. 1 and 2			% change in volume
Date	# of runs	Volume	Date	# of runs	Volume	
			4/10/96	1	6,607	
5/26/94	2	6,385	4/11/96	1	6,437	
5/31/94	2	6,336	5/7/96	2	6,702	
6/2/94	1	6,268	5/8/96	1	6,837	
Total/Avg	5	6,342	Total/Avg	5	6,657	4.73%

WESTBOUND						
7:30 to 8:30 AM Peak HOUR						
Before ICTM			After Mod. 1 and 2			% change in volume
Date	# of runs	Volume	Date	# of runs	Volume	
5/18/94	2	6,050	4/10/96	3	5,847	
5/26/94	2	4,748	4/11/96	2	5,870	
6/2/94	1	5,590				
Total/Avg	5	5,437	Total/Avg	5	5,856	7.15%

4:30 to 5:30 PM Peak HOUR						
Before ICTM			After Mod. 1 and 2			% change in volume
Date	# of runs	Volume	Date	# of runs	Volume	
			4/10/96	1	5,826	
5/26/94	2	5,473	4/11/96	1	5,793	
5/31/94	2	5,698	5/7/96	2	5,675	
6/2/94	1	5,448	5/8/96	1	6,058	
Total/Avg	5	5,558	Total/Avg	5	5,805	4.26%

* Table 2 represents peak hour travel time runs and **volume.** A total of 10 travel time runs were conducted in each direction during each three-hour peak period, 5 of which occurred during the peak hour. Volumes in Table 2 are the average volumes at the Nicollet and Xerxes Avenue Screenlines. Volumes are unadjusted and do not account for seasonai variation.

Figure 3. Change in I-494 Average Peak Hour Travel Speeds

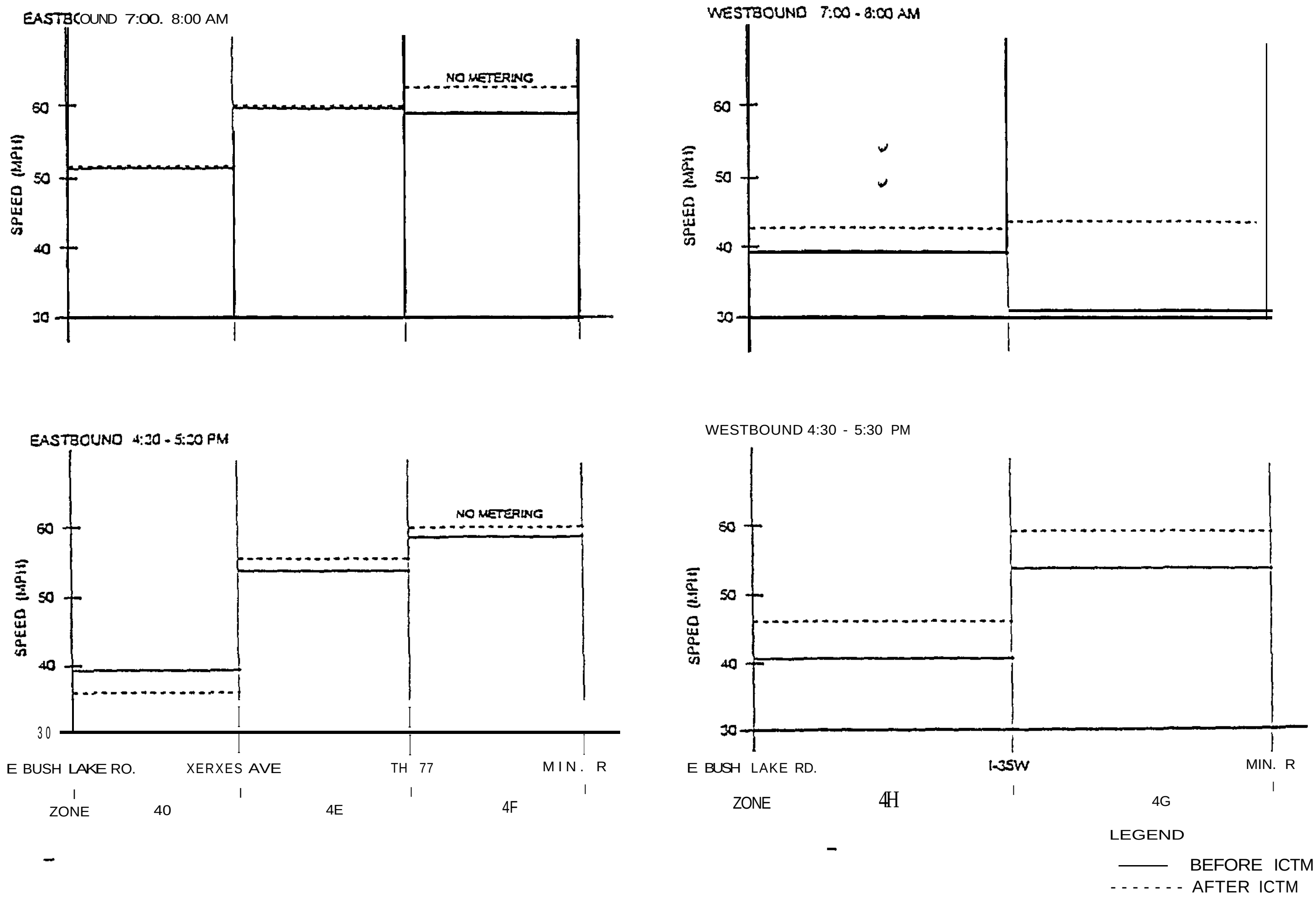


Table 3: Average Freeway Travel Speeds (mph)

	AM Peak Period (6:00-9:00 am)			AM Peak Hour (7:30-8:30 pm)		
	Before	After	% change	Before	After	% change
I-494 EB	56.7	56.5	-0.35%	54.0	52.7	-2.41%
I-494 WB	45.4	50.4	11.01%	35.0	49.8	42.37%
Total	51.1	53.5	4.70%	44.5	51.3	15.19%
	PM Peak Period (3:00-6:00 pm)			PM Peak Hour (4:30-5:30 pm)		
	Before	After	% change	Before	After	% change
I-494 EB	49.2	48.8	-0.81%	44.4	48.8	9.91%
I-494 WB	51.8	55.5	7.14%	50.3	56.3	11.85%
Total	50.5	52.2	3.27%	47.4	52.5	10.94%
AM/PM Total	50.8	52.8	3.94%	45.9	51.9	13.07%
	Weekday Midday (10:30 am-1:30 pm)			Saturday Midday (10:30 am-1:30 pm)		
	Before	After	% change	Before	After	% change
I-494 EB	58.4	60.8	4.11%	60.2	58.9	-2.16%
I-494 WB	59.3	60.7	2.36%	58.8	60.1	2.21%
Total	58.9	60.8	3.23%	59.5	59.5	0.00%

Table 4: Minimum/Maximum Freeway Travel Speeds

	AM Peak Period(6:00 - 9:00 am)								AM Peak Hour (7:30 - 8:30 am)						
	Before			After			% change		Before			After			% change
	min	max	range	min	max	range	in range		min	max	range	min	max	range	in range
I-494 EB	17	68	51	23	68	45	-11.76%	I-494 EB	17	64	47	23	68	45	-4.26%
I-494 WB	10	66	56	17	68	51	-8.93%	I-494 WB	10	61	51	18	68	50	-1.96%
Total	10	68	58	17	68	51	-12.07%	Total	10	64	54	18	68	50	-7.41%
	PM Peak Period (3:00 - 6:00 pm)								PM Peak Hour (4:30 - 5:30 pm)						
	Before			After			%change		Before			After			% change
	min	max	range	min	max	range	in range		min	max	range	min	max	range	in range
I-494 EB	21	64	43	18	67	49	13.95%	I-494 EB	21	64	43	18	67	49	13.95%
I-494 WB	16	64	48	19	69	50	4.17%	I-494 WB	16	64	48	28	69	41	-14.58%
Total	16	64	48	18	69	51	6.25%	Total	16	64	48	18	69	51	6.25%
	Midday Period (10:30 am - 1:30 pm)								Saturday Midday (10:30 am - 1:30 pm)						
	Before			After			% change		Before			After			% change
	min	max	range	min	max	range	in range		min	max	range	min	max	range	in range
I-494 EB	33	67	34	46	71	25	-26.47%	I-494 EB	53	68	15	47	67	20	33.33%
I-494 WB	50	66	16	44	69	25	56.25%	I-494 WB	49	66	17	49	66	17	0.00%
Total	33	67	34	44	71	27	-20.59%	Total	49	68	19	47	67	20	5.26%

d) FREEWAY RAMP METER DELAY: It was reported in IETP 7 that corridor motorists perceive freeway entrance ramp meter delays to average just over four minutes prior to ICTM. Approximately 92 percent of corridor residents indicated they entered the freeway system at a metered ramp. Sample delay measurements were taken at eight ramps onto I-494 before and after ICTM. As shown on Table 5, ramp delays per vehicle ranged between 0. 11 to 11.19 minutes prior to ICTM. In comparison, delay measurements after ICTM were reduced at 10 of 14 ramps time periods with reductions between 0.3 to 10.5 1 minutes per vehicle. Four ramp measurements showed a delay increase of between 0.71 and 3.04 minutes per vehicle. In total, as shown on Table 6, delay at the eight sample ramps during the 7:30 to 8:30 AM peak hour was significantly reduced by 661.69 minutes, or 11.03 vehicle-hours, and during the 4:30 to 5:30 PM peak hour by 5,590.36 minutes, or 93.17 vehicle-hours. These ramp delay results are based on a one day comparative sample.

Table 5: Average Freeway On-Ramp Delay

Ramp Location		Average Relay Per Vehicle (minutes/vehicle)					
		AM Peak Hour (7:30-8:30 am)			PM Peak Hour (4:30-5:30 pm)		
ID	Description	Before	After	% change	Before	After	% change
4D4	France Avenue NB to EB I-494	0.11	0.02	-81.15%	5.53	6.24	12.89%
4E1	Penn Avenue to EB I-494	0.03	0.00	-100.00%	0.21	0.00	-100.00%
4E4	Lyndale Avenue to EB I-494	*0.00	*0.00	-	1.53	0.09	-94.09%
4E6	12th Avenue to EB I-494	*0.00	*0.00	-	**	0.00	-
4G2	24th Avenue to WB I-494	1.90	3.09	62.54%	10.94	0.43	-96.11%
4G7	Lyndale Avenue to WB I-494	6.19	4.82	-22.10%	3.99	0.31	-92.19%
4H2	Penn Avenue to WB I-494	7.86	2.65	-66.31%	1.38	3.15	127.88%
4H4	France Avenue SB to WB I-494	6.52	9.56	46.67%	11.19	4.68	-58.19%

* Ramp is not metered during this time period
**Missing entrance volume data

Table 6: Freeway On-Ramp Delay Summary

Ramp No	Vehicle Minutes of Delay					
	7:30 - 8:30 AM			4:30 - 5:30 PM		
	Before	After	Difference	Before	After	Difference
4D4	34.98	5.72	-29.26	1.885.73	2.252.64	+366.91
4El	12.72	0	-12.72	252.00	0	-252.00
4E4	na	na	na	419.22	36.90	-382.32
4E6	na	na	na	na	na	na
4G2	300.20	565.47	+265.27	4,113.44	233.06	-3,880.38
4G7	965.64	949.54	-16.10	1,360.59	190.03	-1,170.56
4H2	1,320.48	537.95	-7'83.00	291.18	1.020.60	+729.42
4H4	984.52	898.64	-85.88	2,517.75	1,516.32	-1,001.43
Total			-661.69			-5,590.36

e) ARTERIAL SYSTEM TRAVEL CHARACTERISTICS: Data was collected from several sources on traffic operating conditions on the arterial street network in the I-494 study corridor. As previously noted, the adaptive traffic signal control system was not operational at the time of data collection for system evaluation. The traffic data collected in 1996 will be used for baseline condition comparison purposes to 1997 data that reflects the impact of a complete operational traffic signal control system in the corridor. Baseline data was also collected in IETP 7 on corridor resident, business and motorist perceptions on traffic operating conditions and system performance. According to that data, motorists did not perceive a change in travel times on the arterial street system during the year prior to ICTM. This perception was supported by travel time measurements collected on the east-west parallel and north-south cross streets in the study corridor. Corridor motorists also expressed frustration with inefficient signal timing at arterial intersections in the study corridor with 60 percent feeling they stop at signals on their most frequented arterial routes when there is no traffic in the opposing direction.

From a safety standpoint, baseline accident data indicates that the arterial street system experienced a total of 745 accidents in 1994, of which 166 accidents, or 22 percent, occurred on parallel east-west streets. The highest number of accidents on east-west streets were reported on 76th Street, with 39 accidents, 23.5 percent of the total; on 79t Street with 33 accidents, 19.9 percent of the total; and on 80th Street, with 32 accidents, 19.3 percent of the total. Those three streets accounted for nearly two-thirds of the east-west arterial accidents prior to ICTM. Similarly, of the 579 accidents reported on north-south cross streets in the study corridor, I-35W experienced 107 accidents, or 18.5 percent of the total; France Avenue experienced 73 accidents, 12.6 percent of the total; TH 100 experienced 67 accidents, 11.6 percent of the total; Portland Avenue experienced 61 accidents, 10.5 percent of the total; and Penn Avenue experienced 58 accidents, or 1 .O percent of the total. It is noted that I-3 5W and TH 100 are freeway facilities. Those five north-south facilities accounted for 63.2 percent; or nearly two-thirds, of the total accidents reported in 1994. Of the accidents on these five facilities, 22.3 percent were on I-35W and TH 77. Of the 745 total arterial street accidents reported in 1994, 85 accidents occurred during the morning peak period and 186 accidents occurred during the evening peak period. Approximately 36 percent of the total accidents were property damage only.

In comparison to these accident statistics, motorists indicated they did not perceive that traffic safety problems exist in the I-494 study corridor. There were very few concerns expressed of unsafe driving conditions on the arterial street system prior to ICTM. The safety impact of before/after accident conditions will be presented in the final ICTM evaluation report.

- **Evaluation Area 4:** Ability of ICTM to make use of available transportation infrastructure; and its expandability or transferability to another area.

According to traffic volume data collected in IETP 1, corridor-wide screenline volumes have basically decreased since 1995. During the peak period and midday time periods, as shown on Table 7, all time periods exhibited a decrease in volume between 1.0 to 3.8 percent between 1995 and 1996, except the weekday 7:00 to 8:00 AM peak hour and the midday time period from 11:00 AM to 2:00 PM, which exhibited a volume increase of 0.5 and 2.1 percent, respectively. More important, system utilization between the freeway and east-west surface street arterial system remained relatively constant during all time periods ranging between +0.8 to -1.3 percent.

Data collected in IETP 7 indicates that the majority of I-494 motorists only occasionally used arterial street system prior to ICTM. Over 56 percent of surveyed motorists indicated they are very or extremely likely to use the freeway for short trips. Those findings are consistent with screenline traffic trends. The impacts of adaptive arterial street signal controls ability to change this travel pattern will be reported on the next interim report.

Table 7. Change in System Utilization

Time Period	Summation of Nicollet and Xerxes Screenline Traffic Distribution								% Change in Total Volume	% Change in Arterial Volume
	BEFORE				AFTER					
	Total	1494	Arterials	% Arterial	Total	I-494	Arterials	% Arterial		
6:00-9:00AM	71,091	63,394	7,697	10.8	70,384	62,485	7,899	11.2	-1.0	+0.4
7:00-8:00AM	26,682	23,155	3,527	13.2	26,806	23,030	3,776	14.0	+0.5	+0.8
300-6:00PM	86,553	70,764	15,789	18.2	84,047	69,577	14,460	17.2	-2.9	-1.0
4:00-5:00PM	29,802	23.693	5,839	19.6	28,722	23,460	5,262	18.3	-3.6	-1.3
Weekday * 11:00AM-2:00PM	63,103	53,282	9,821	15.6	60,676	51,544	9,132	15.1	-3.8	-0.5
Saturday * 11:00AM-2:00PM	58,833	51,079	7,754	13.2	60,069	51,724.	8,345	13.9	+2.1	+0.7

*Note: Mid-day and Saturday volumes are adjusted for seasonal traffic variations.

The cost of implementing an ICTM system provides important information for future projects that look to expand the system in the Twin Cities area or to start up a system in another community. For reporting purposes, costs have been reported in Test Plan 5 into two categories: fixed and ongoing. Fixed costs are capital expenditures for implementation of the system and include project plan development, adaptive contro1 design and equipment and detection technology development. In comparison, ongoing costs include operations and maintenance of the system and "other" which includes monthly computer service agreements and communication system leasing costs. The interim costs reported to date for Modules 1 and 2, as shown on Tables 8 and 9, total $4.3 1 million plus ongoing monthly "other" costs of $1,314.00.

Approximate unit costs for ICTM, based on the preliminary data reported in Table 8, indicates a unit cost for estimation of system expansion or deployment to other areas of approximately: $300,000 per mile of freeway; $100,000 per mile of corridor arterial; and $115,000 per freeway ramp terminal intersection. It is noted that these unit costs are very preliminary and will be refined in future ICTM evaluation reports.

Table 8. Summary of ICTM Costs for Modules 1 and 2

Costs	(dollars)	% Total
1. Fixed		
Project Development	**$656,900**	22.9
Adaptive Traffic Signal Control	873,400	30.4
Adaptive Ramp Meter Control	417,000	14.5
Alternative Detection Technology	332,800	11.6
Subtotal	$2,280,100	79.4
2. Ongoing (Operations/Maintenance)	592,400	20.6
TOTAL	$2,872,500	100.0%

- **Evaluation Area** 5: Ability of multiple transportation agencies to work together and manage traffic in a congested freeway corridor.

The ability of transportation agencies to work together to implement ICTM is documented in two basic areas. These areas involve additional funding contributions for project deployment and agreements on operation/management of the ICTM traffic control system.

The cost-sharing of ICTM project funding is a positive indicator of public agency agreement to share in the development of an adaptive control system in the I-494 corridor. The cost-sharing includes those contributions above the fixed and ongoing capital expenditures described previously. For documentation purposes, project costs can be categorized as "public" and "private" sector contributions to the project, as shown on Table 9.

As shown on Table 9, local communities have funded about 17.6 percent of the ICTM cost contributions through the deployment of Modules 1 and 2 with private-sector contributions totaling about 15.9 percent. The remaining two-thirds of project contributions have been funded by the MnDOT.

Table 9. ICTM Cost Contributions for Modules 1 and 2

Category	Cost	% Total
1. Public Sector		
MnDOT	$960,300	66.5
Hennepin County	165,100	11.5
City of Bloomington	58,600	4.1
City of Edina	6,100	0.4
City of Richfield	23.300	1.6
Subtotal	$1,213,500	84. I
2. Private Sector	229,700	15.9
TOTAL	$1,443,100	100.0%

In addition to these cost-sharing actions, each community directly involved in the management of the transportation network in the ICTM corridor have agreed to cooperate on the operation of that network. The Minnesota Department of Transportation has served as the lead coordinating agency with Hennepin County and the cities of Bloomington, Edina and Richfield in the development of system operating principles and policies, Cooperative agreements have been approved by each agency on project cost sharing, maintenance and operation, as documented in the appendix to this report. The MnDOT serves as the principal contracting agency for the ICTM project design and development. However, through the use of monthly management team committee meetings, all design and deployment issues are agreed to prior to MnDOT approval.

Principal system operation issues agreed to are summarized on Table 10.

In addition to these operation agreements, all agencies also agreed to uniform reporting procedures, staff training and communication protocol.

Basic maintenance issues were agreed to with respect to the use of a standard signal maintenance form, preparation of annual system service/replacement cost budgets and the lack of a need for a master maintenance agreement as long as appropriate municipal and signal agreements are developed on cost sharing and maintenance responsibilities.

With regard to potential liability issues, several standard procedures were identified for system maintenance specific to records, scheduling and uniform practice. No liability claims have been reported to date due to ICTM system operation. A potential liability exposure issue could occur when an agency is assisting with traffic maintenance outside the agency's jurisdictional boundaries or on another agency's traffic control cabinet within its jurisdictional area. The agreements developed for this project and the use of good maintenance practices should protect against this potential problem.

In general, cooperation and management between the agencies affected by ICTM has been very strong and successful.

Table 10. Principal ICTM Operation Issue Agreements

1. The agency that owns a particular traffic signal is responsible for its operation and maintenance;
2. The ICTM system operator is responsible for establishing incident response procedures, including route diversions, providing motorist information, extended ramp meter operation, and manual control of system elements;
3. If route diversions are used, predetermined route plans should be used where appropriate with the appropriate community engineer notified of any diversion conditions;
4. It is the ICTM system operator's responsibility to coordinate with the TMC Information Officer regarding response actions-including manual override of the system. The Information Officer shall assess incident significance and appropriate notification of appropriate local authorities;
5. When manual control of ICTM system components within an agency's jurisdiction is taken, that agency shall notify appropriate representatives of other affected jurisdictions;
6. **Any agency** is able to control arterial VMS if not otherwise under control of the ICTM system operator;
7. **A** jurisdiction may take control of another jurisdiction's system components only through proper arrangements and permission between affected agencies.

V. Conchsions

Traffic volumes at two screenline locations used to monitor east-west traffic volume trends in the study area indicate that overall peak period average two-way total traffic levels decreased by 1 .O to 3.6 percent except during the 7:00 to 8:00 AM time period when it increased by about 0.5 percent. These screenline volumes also indicate that there has been no shift to date in the traffic volume distribution between the east-west arterial and freeway systems.

The implementation of ICTM Modules 1 and 2 has coincided with several positive changes in traffic operations in the I-494 corridor. These changes are limited to the freeway system where adaptive ramp meter control was implemented. There were no changes documented in this report for the arterial street system which did not have operational adaptive traffic signal controls in place at the time of data collection. As shown on summary Table 11, average freeway peak period traffic volumes during travel speed data collection periods increased by (+)2.9 to (+)7.2 percent. Freeway travel speeds were improved at five of eight peak-traffic time period measurements. Westbound speeds were improved in all cases, increasing average speeds from a low of 35.0 mph during the 7:30 to 8:30 AM peak hour to 49.8 mph, and resulting in all speeds **on** I-494 approaching a value of 50 mph, ranging between an improved speed boundary of 48.8 to 56.5 mph.

Freeway travel speed consistency varied between different peak traffic time periods with speed consistency improved during three time periods and unchanged during three other time periods. Only two time periods showed an increase in the range of minimum/maximum speeds.

Finally, as also shown on Table 11, average vehicle delays at freeway on-ramps were reduced by a range of 1.44 to 10.5 1 minutes at six of 13 ramp delay measurements and increased by 0.71 to 3.04 minutes at four delay measurements. The net result of this improved ramp meter operation with adaptive control indicates a net vehicle delay reduction of 11 .O to 93.1 vehicle-hours during the 7:30 to 8:30 AM and 4:30 to 5:30 PM time periods, respectively at the seven ramps evaluated in this study. These ramp delay results are based on **a** one day comparative sample.

Public perceptions indicate that freeway travel speeds were decreasing prior to implementation of ICTM and that travel speed consistency was relatively constant. The "before/after" travel speed data summarized above indicates-that adaptive ramp meter control may have reversed a reduced travel speed trend and improved travel speed consistency on I-494 while measurably reducing ramp meter delays.

Baseline traffic conditions for 1994 indicate that there were 754 arterial street accidents in the study corridor, of which 22 percent occurred on east-west streets and were evenly distributed between 76th, 79th and 80th Streets. Of the remaining 78 percent that occurred on north-south streets, the highest accident frequencies were reported on France, Portland and Penn Avenues, in addition to the I-35W and TH77 freeway facilities.

Motorists indicated there were very few concerns of unsafe driving conditions on the arterial street system in the I-494 corridor. Motorists did feel, however, frustration with inefficient signal timing on the arterial street system. Motorists indicated they only occasionally used the arterial street system prior to ICTM. Over 56 percent of surveyed motorists indicated they are “very” or “extremely likely” to use the freeway system for short trips. Potential changes to these safety and travel pattern perceptions as a result of ICTM will be verified in future ICTM evaluation reports.

ICTM implementation costs have totaled nearly $4.3 1 million dollars to date for capital expenditures relating to design, deployment and operation. Community agency cooperation is demonstrated through cost sharing and operational agreements that have resulted in MnDOT, local communities and the private sector providing $1.44 million dollars or about 33% of the total project cost in “hard” and “soft” contributions. No major operational or liability issues have been identified through the course of the ICTM project to date.

The evaluation will continue to monitor the results identified on the freeway system throughout the test to ensure that results are genuine and consistent. The evaluation will also address ICTM impacts on arterial street system operations and public awareness/perception of those changes. These findings will be documented in subsequent reports.

Table 11. Freeway Evaluation Summary

1. Average Screenline Traffic Volume Levels During Travel Speed Data Collection

Time Period	Direction	Volume Before	Volume After	% Change	
7:30 – 8:30 AM	EB	5,471	5,633	+2.88	↑
	WB	5,437	5,856	+7.15	↑
4:30 – 5:30 PM	EB	6,432	6,657	+4.73	↑
	WB	5,558	5,805	+4.26	↑

2. Average Travel Speed

Time Period	Direction	Speed (mph) Before	Speed (mph) After	Change %	
6:00 – 9:00 AM	EB	56.7	56.5	-0.4	-
	WB	45.4	50.4	11.0	↑
7:30 – 8:30 AM	EB	54.0	52.7	-2.4	-
	WB	35.0	49.8	42.4	↑
3:00 – 6:00 PM	EB	49.2	48.8	-0.8	-
	WB	51.8	55.5	7.1	↑
4:30 – 5:30 PM	EB	44.4	48.8	9.9	↑
	WB	50.3	56.3	11.8	↑

3. Travel Speed Consistency

Time Period	Direction	Speed Variation Change (mph)	% Change	
6:00 – 9:00 AM	EB	-6	-11.8	↓
	WB	-5	-8.9	↓
7:30 – 8:30 AM	EB	-2	-4.3	-
	WB	-1	-2.0	-
3:00 – 6:00 PM	EB	+6	14.0	↑
	WB	+2	4.2	-
4:30 – 5:30 PM	EB	+6	14.0	↑
	WB	-7	-14.6	↓

4. Ramp Delay

Ramp	Direction	Time Period: 7:30 – 8:30 AM Ave. delay (min)		Time Period: 4:30 – 5:30 PM Ave. delay (min)	
4D4	EB	-0.09	-	0.71	↑
4E1	EB	-0.03	-	-0.21	-
4E4	EB	n/a		-1.44	↓
4G2	WB	1.09	↑	-10.51	↓
4G7	WB	-1.37	↓	-3.68	↓
4H2	WB	-5.21	↓	1.77	↑
4H4	WB	3.04	↑	-6.51	↓

APPENDIX

TABLE OF CONTENTS

This appendix contains summary baseline data that has been collected under the initial phase of ICTM evaluation for Modules 1 and 2 and the related Measures of Effectiveness (MOEs) that apply directly to the evaluation of that data. Each test plan contains a description of the test purpose, schedule of test activities to date, data tabulations, description of analysis methods and results/interpretations.

Test Plan No. 1 - Change in Traffic Utilization of Transportation System in Corridor.

1. Test Purpose

The purpose of this test plan is to evaluate the effectiveness of the ICTM system to utilize the available capacity of the arterial street system to maintain the flow of traffic on the freeway system and the ICTM corridor as a whole. The evaluation compares before and after traffic volume levels and its distribution between the freeway and arterial street systems passing through the study corridor at selected "screenline" locations. Analysis is conducted during time periods of normal, recurrent freeway congestion and during freeway system incidents.

2. Schedule of Test Activities

Task	Dates Conducted
1. Collect Before Screenline Volumes	August 8 - September 18, 1995
2. Collect Post Mod. l/2 Screenline Volumes	April 8-20 and May 6-l1, 1996
3. Perform Analysis	June - September, 1996

3. Tabulated Data Collected

Tabulated hourly screenline traffic volume data is available through the ICTM Project Manager and/or HNTB Corporation. As noted in Section 2 above, traffic volume collection periods for "before/after" data comparisons were undertaken during different seasons of the year. "Before" Modules 1 and 2 data was collected during the Fall of 1995, with "after" Modules 1 and 2 data collected during the Spring of 1996. Based on discussions with Mn/DOT staff, it was agreed that peak hour and peak period weekday commuter freeway traffic volumes should not be adjusted for seasonal variations. It was also agreed that the mid-day and Saturday 1l:00 AM to 2:00 PM time period traffic data, which reflects seasonal travel demand changes, may be correctable for seasonal variation. Seasonal adjustment factors for mid-day and Saturday time periods are based on historical daily 24-hour traffic data collected by the Minnesota Department of Transportation for the Minneapolis/St. Paul metropolitan area.

4. Analysis Methods

There are two MOE's that are directly applied to screenline traffic data collected as a part of this test plan.

MOE l-l.1 - *Increase in screenline traffic volumes during periods of recurrent traffic congestion.*

Screenline traffic volume data is used to assess the effectiveness of ICTM to improve utilization of the available transportation infrastructure with in the study corridor, The analysis includes a before/after comparison of corridor traffic volume levels and arterial/freeway system traffic volume distributions for Modules. 1 and 2. The effectiveness of ICTM to improve traffic utilization of corridor capacity during periods of recurrent freeway traffic congestion is considered to be confirmed by a 10% increase in average arterial screenline volumes, a 5% increase in average freeway traffic volume levels, a 10% increase in the total corridor screenline average traffic volumes, and/or a 10% increase in the proportion of corridor traffic using the arterial street system.

Statistical analysis of screenline traffic volume data includes a chi-square test at a 95% confidence level on several combinations of screenline volumes. The analysis of screenline volumes includes the combination of east and westbound traffic volumes and the sum total of Nicollet and Xerxes Avenue screenline data. In addition to I-494 the Nicollet screenline includes 76th, 77th and 79th Streets, while the Xerxes screenline includes I-494, 76th and 80th Streets. The analysis is performed for the following time periods:

1) 6:00 to 9:00 AM Peak Period
2) *7:00* to 8:00 AM Peak Hour
3) 11:00 AM to 2:00 PM Weekday Midday Period
4) *3:00* to 6:00 PM Peak Period
5) *4:00* to 5:00 PM Peak Hour
6) 11:00 AM to 2:00 PM Saturday Midday Period.

MOE l-3.1- *Increase in screenline traffic volume in response to incident management plans.*

MOE l-3.1 is not addressed as part of the Module 1 and 2 evaluation. Complete incident management plans will be implemented as part of ICTM Module 4 with evaluation of their effects on screenline traffic volumes included in the fmal report.

5. Results and Interpretations

MOE 1-1.1 - *Increase in screenline traffic volumes duringperiods of recurrent traffic congestion.*

- Hypothesis 1 - 1.1 a - *There is an increase in arterial screenline traffic volume during periods of normal, recurrentfreeway traffic congestion.*

Table Al-l: Actual Arterial Screenline Traffic Volumes (vehicles)

	AM Peak Period (6:00-9:00 am)			PM Peak Period (3:00-6:00 pm)		
	Before	After	% change	Before	After	% change
76th St EB at Nicollet Ave	175	217	24.00%	853	704	-17.47%
77th St EB at Nicollet Ave	307	471	53.42%	867	1,730	99.54%
79th St. EB at Nicollet Ave	501	368	-26.55%	1,106	890	-19.53%
EB Nicollet Total	983	1,056	7.43%	2,826	3,324	17.62%
76th St WB at Nicollet Ave	613	333	-45.68%	678	369	-45.58%
77th St WB at Nicollet Ave	680	1,276	87.65%	1,218	1,368	12.32%
79th St. WB at Nicollet Ave	886	765	-13.66%	1,333	1,063	-20.26%
WB Nicollet Total	2,179	2,374	8.95%	3,229	2,800	-13.29%
76th St EB at Xerxes Ave	537	683	27.19%	2,220	2,154	-2.97%
80th St EB at Xerxes Ave	727	561	-22.83%	4,314	2,938	-31.90%
EB Xerxes Total	1,264	1,244	-1.58%	6,534	5,092	-22.07%
76th St WB at Xerxes Ave	1,780	1,667	-6.35%	1,759	1,631	-7.28%
80th St WB at Xerxes Ave	1,491	1,481	-0.67%	1,487	1,457	-2.02%
WB Xerxes Total	3,271	3,148	-3.76%	3,246	3,088	-4.87%
Arterial System Total	7,697	7,822	1.62%	15,835	14,304	-9.67%
	Weekday Midday (11:00 am-2:00 pm)			Saturday Midday (11:00 am-2:00 pm)		
	Before	After	% change	Before	After	% change
76th St EB at Nicollet Ave	397	341	-14.11%	395	461	16.71%
77th St EB at Nicollet Ave	706	966	36.83%	779	1,087	39.54%
79th St EB at Nicollet Ave	1,030	828	-19.61%	745	733	-1.61%
EB Nicollet Total	2,133	2,135	0.09%	1,919	2,281	18.86%
76th St WB at Nicollet Ave	430	229	-46.74%	510	312	-38.82%
77th St WB at Nicollet Ave	961	942	-1.98%	1,100	1,084	-1.45%
79th St WB at Nicollet Ave	1,143	1,029	-9.97%	811	864	6.54%
WB Nicollet Total	2,534	2,200	-13.18%	2,421	2,260	-6.65%
76th St EB at Xerxes Ave	985	961	-2.44%	720	861	19.58%
80th St EB at Xerxes Ave	2,474	1,801	-27.20%	1,690	1,338	-20.83%
EB Xerxes Total	3,459	2,762	-20.15%	2,410	2,199	-8.76%
76th St WB at Xerxes Ave	1,160	1,070	-7.76%	982	1,118	13.85%
80th St WB at Xerxes Ave	1,463	1,608	9.91%	759	1,061	39.79%
WB Xerxes Total	2,623	2,678	2.10%	1,741	2,179	25.16%
Arterial System Total	10,749	9,775	-9.06%	8,491	8,919	5.04%

* 77th Street was not fully constructed when "before" data was collected

Table Al-l provides a summary of screenline traffic volumes on the arterial street system. This data was not adjusted with daily factors to account for the seasonal difference in before/after data collection periods. Data contained in Table Al - 1 appears to show a wide variance between "before/after" screenline traffic volume conditions. In total, two-way arterial traffic volume levels appear to have changed randomly ranging from an average increase of 5.04% during the Saturday Midday Period to a decrease of 9.67% during the Weekday PM Peak Period. Traffic volume changes on individual facilities range greatly from a high of (+)99.54% on eastbound 77th Street to a low of (-)46.74% on westbound 76th Street. Some of these changes were expected and are attributed to the reconstruction improvement of 77th Street. Hypothesis 1 - 1.1 a, pertaining to arterial system traffic volume changes, is not addressed at this point in the evaluation since deployment of ICTM has not had a direct effect on the arterial street system. The data collected as "after" data will be used as the "before" data base for the evaluation of Module 3. This should provide a more reliable comparison of unadjusted arterial volume changes for evaluation of Module 3 as the "after" data was collected during a continuous three week time period which was not the case with the collection of "before" traffic volume data for Modules 1 and 2. In addition, traffic volume patterns at each screenline will be monitored on a monthly basis to identify any trends that may influence traffic data reliability for this test. Arterial screenline traffic volume changes will be evaluated after implementation of Module 3.

- Hypothesis l-l.1 b - *There is an increase in the freeway system 's operating capacity during periods of recurrent freeway traffic congestion.*

  For study purposes, this analysis is divided into peak and mid-day time period findings.

  Tables Al-2 and Al-3 provide a direct volume comparison and (Chi`-Square Test of average freeway screenline peak period traffic volumes from "before" and "after" implementation of Modules 1 and 2.

Table Al-2 Average Actual Freeway Peak Period Traffic Volumes

	AM Peak Period (6:00-9:00 am)			AM Peak Hour (7:00-8:00 am)		
	Before	After	% change	Before	After	% change
I-494 EB at Nicollet Ave	13,042	13,421	2.91%	4,996	5,202	4.12%
I-494 WB at Nicollet Ave	15,611	14,973	-4.09%	5,502	5,355	-2.67%
I-494 EB at Xerxes Ave	15,985	15,812	-1.08%	6,022	6,024	0.03%
I-494 WB at Xerxes Ave	18,756	18,279	-2.54%	6,635	6,449	-2.80%
Total	63,394	62,485	-1.43%	23,155	23,030	-0.54%
	PM Peak Period (3:00-6:00 pm)			PM Peak Hour (4:00-5:00 pm)		
	Before	After	% change	Before	After	% change
I-494 EB at Nicollet Ave	18,016	17,840	-0.98%	6,299	6,239	-0.95%
I-494 WB at Nicollet Ave	16,046	15,673	-2.32%	5,402	5,227	-3.24%
I-494 EB at Xerxes Ave	18,992	18,582	-2.16%	6,357	6,184	-2.72%
I-494 WB at Xerxes Ave	17,710	17,482	-1.29%	5,905	5,810	-1.61%
Total	70,764	69,577	-1.68%	23,963	23,460	-2.10%

Table Al-3 Chi-Square Test of Average Actual Freeway Peak Period Traffic Volumes

	Recorded. Volume	Expected Volume	Residual	Chi-Square	D.F.	Significance
AM Peak Period (6-9 am)						
Before	63394	62939.5	454.50			
After	62485	62939.5	-454.50	6.5641	1	0.0104 $P<0.05$
AM Peak Hour (7-8 am)						
Before	23 155	23092.5	62.50			
After	23030	23092.5	-62.50	0.3383	1	0.5608 $P>0.05$
PM Peak Period (3-6 pm)						
Before	70764	70170.5	593.50			
After	69577	70170.5	-593.50	10.0396	1	0.0015 $P<0.05$
PM Peak Hour (4-5 pm)						
Before	23963	23711.5	251.50			
After	23460	23711.5	-25 1.50	5.3352	1	0.0209 $P<0.05$

Freeway screenline volume results do not support the hypothesis that the freeway's operating capacity will be increased by ICTM. As shown in Table Al-2, changes in east and westbound freeway traffic volume levels have varied by a range of(+) 4.12% to (-) 4.09%. There are no comparison results which meet the evaluation goal of 5% increase in freeway operating capacity. Based on the Chi-square test results displayed in Table Al-3, there were statistically significant lower volumes after implementation of Modules 1 and 2 during the 6:00 to 9:00 AM Peak Period, 3:00 to 6:00 PM Peak Period, and 4:00 to 5:00 PM Peak Hour. No statistically significant changes were experienced during the 7:00 to 8:00 AM Peak Hour.

Table Al-4: Annual Average Freeway Midday Traffic Volumes (vehicles)*

	Weekday Midday (11:00 am-2:00 pm)			Saturday Midday (11:00 am-2:00 pm)		
Location	Before	After	% change	Before	After	% change
I-494 EB at Nicollet Ave	11,993	11,375	-5.15%	11,768	12,497	6.19%
I-494 WB at Nicollet Ave	12,394	11,720)	-5.4,4%	12,069	11,559	-4.23%
I-494 EB at Xerxes Ave	14,735	14,380	-2.41%	14,096	14,599	3.57%
I-494 WB at Xerxes Ave	14,160	14,069	-0.64%	13,146	13,069	-0.59%
Total	53,282	51,544	-3.26%	51,079	51,724	1.26%

*Note: Freeway midday volumes are adjusted for seasonal variation.

Table A1-5: Chi-Square Test of Annual Average Freeway Midday Traffic Volumes

Time Period	Recorded Volume	Expected Volume	Residual	Chi-Square	D.F.	Significance
Midday Period (11 am - 2 pm)						
Before	53282	52413.0	869.00			
After	51544	52413.0	-869.00	28.8158	1	0.0000 P<0.05
Saturday Midday (11 am - 2 pm)						
Before	51079	51401.5	-322.50			
After	51724	51401.5	322.50	4.0468	1	0.0443 P<0.05

After adjusting the midday freeway traffic volume data for seasonal variances it can be seen from the results of Table Al-4 that changes in east and westbound volumes varied by a range of (+)6.19% to (-)5.44%. Based on the Chi-Square test results displayed in Table Al-5, there were significantly higher freeway traffic volumes during the Saturday 11:00 AM to 2:00 PM midday time period and significantly lower traffic volumes during the weekday 11:00 AM to 2:00 PM midday time period. The weekday midday findings are consistent with the weekday peak hour findings of reduced freeway traffic levels after implementation of Modules 1 and 2 when compared to the time period prior to implementation.

- Hypothesis *l-1* .lc - *There is an increase in total corridor screenline traffic volume during periods of recurrentfreeway traffic congestion.*

Tables Al -6 and Al -7 provide a direct volume comparison and Chi-Square Test, respectively, of average peak period corridor-wide screenline traffic volume from “before” and "after” implementation of Modules 1 and 2.

The actual corridor-wide screenline volumes for total freeway and arterial street peak periods do not support the hypothesis that the total corridor screenline traffic volume will be increased by ICTM. As shown in Table Al-6, changes in total screenline traffic volume levels have varied by a range of (+) 4.54% to (-) 8.70% when compared to traffic volume levels prior to deployment of Modules 1 and 2. There are no comparison results which meet the evaluation goal of a 10% increase in corridor-wide screenline traffic volumes. Based on the Chi-square test results displayed in Table Al-7, there were statistically significant lower volumes after implementation of Modules 1 and 2 during the 3:00 to 6:00 PM Peak Period and 4:00 to 5:00 PM Peak Hour time periods. No statistically significant changes were experienced during the 6:00 to 9:00 AM Peak Period and 7:00 to 8:00 AM Peak Hour. Similarly, seasonally adjusted corridor screenline volumes, shown in Table Al-8 for total freeway and arterial street midday and Saturday 11:00 AM to 2:00 PM time periods showed statistically lower traffic volume levels after implementaiton of Modules 1 and 2, as reported on Table Al -9.

Table Al-6: Average Actual Corridor Screenline Peak Period Traffic Volumes

	AM Peak Period (6:00-9:00 am)			AM Peak Hour (7:00-8:00 am)		
	Before	After	% change	Before	After	% change
EB at Nicollet Ave	14,025	14,484	3.27%	5,394	5,639	4.54%
WB at Nicollet Ave	17,790	17,382	-2.29%	6,537	6,570	0.50%
EB at Xerxes Ave	17,249	17,060	-1.10%	6,549	6,565	0.24%
WB at Xerxes Ave	22,027	21,458	-2.58%	8,202	8,032	-2.07%
Total	71,091	70,384	-0.99%	26,682	26,806	0.46%
	PM Peak Period (3:00-6:00 pm)			PM Peak Hour (4:00-5:00 pm)		
	Before	After	% change	Before	After	% change
EB at Nicollet Ave	20,842	21,181	1.63%	7,305	7,423	1.62%
WB at Nicollet Ave	19,275	18,481	-4.12%	6,528	6,226	-4.63%
EB at Xerxes Ave	25,460	23,740	-6.76%	8,919	8,143	-8.70%
WB at Xerxes Ave	20,956	20,645	-1.48%	7,050	6,930	-1.70%
Total	86,533	84,047	-2.87%	29,802	28,722	-3.62%

Table Al-7: Chi-Square Test on Average Actual Corridor Screenline Peak Period Traffic Volumes

	Recorded Volume	Expected Volume	Residual	Chi-Square	D.F.	Signifance
AM Peak Period (6-9 am)						
Before	71091	70737.5	353.50			
After	70384	70737.5	-353.50	3.5331	1	0.0602 P>0.05
AM Peak Hour (7-8 am)						
Before	26682	26744.0	-62.00			
After	26806	26744.0	62.00	0.2875	1	0.5918 P>0.05
PM Peak Period (3-6 pm)						
Before	86533	85290.0	1243.00			
After	84047	85290.0	-1243.00	36.2305	1	0.0000 P<0.05
PM Peak Hour (4-5 pm)						
Before	29802	29262.0	540.00			
After	28722	29262.0	-540.00	19.9303	1	0.0000 P<0.05

Table Al-8: Annual Average Corridor Screenline Midday Traffic Volumes (vehicles)

Location	Weekday Midday (11:00 am-2:00 pm)			Saturday Midday (11:00 am-2:00 pm)		
	Before	After	% change	Before	After	% change
EB at Nicollet Ave	13,934	13,360	-4.12%	13,515	14,626	8.22%
WB at Nicollet Ave	14,699	13,784	-6.22%	14,272	13,676	-4.18%
EB at Xerxes Ave	17,908	16,962	-5.28%	16,307	16,656	2.14%
WB at Xerxes Ave	16,562	16,570	0.05%	14,739	15,111	2.52%
Total	63,103	60,676	-3.85%	58,833	60,069	2.10%

*Note: Screenline midday volumes are adjusted for seasonal variation.

Table A1-9: Chi-Square Test on Annual Average Corridor Screenline Midday Traffic Volumes

Time Period	Recorded Volume	Expected Volume	Residual	Chi-Square	D.F.	Significance
Midday Period (11 am - 2 pm)						
Before	63103	61889.5	1213.50			
After	60676	61889.5	-1213.50	47.5875	1	0.0000 P<0.05
Saturday Midday (11 am - 2 pm)						
Before	58833	59451.0	-618.00			
After	60069	59451.0	618.00	12.8484	1	0.0003 P<0.05

- Hypothesis 1- *1.1 d - There is an increase in the proportion of corridor traffic distributed on the arterial street system duringperiods of recurrent traffic congestion.*

Table A1-10: Percentage of Corridor Screenline Traffic on the Arterial Street System

	AM Peak Period (6:00-9:00 am)			AM Peak Hour (7:00-8:00 am)		
	Before	After	% change	Before	After	% change
EB at Nicollet Ave	7.48%	7.46%	-0.28%	7.85%	7.86%	0.13%
WB at Nicollet Ave	13.00%	14.06%	8.17%	16.76%	18.77%	11.96%
EB at Xerxes Ave	7.86%	7.43%	-5.48%	8.62%	8.38%	-2.76%
WB at Xerxes Ave	15.80%	14.97%	-5.24%	20.26%	19.91%	-1.71%
Total	11.54%	11.37%	-1.43%	14.06%	14.28%	1.57%
	PM Peak Period (3:00-6:00 pm)			PM Peak Hour (4:00-5:00 pm)		
	Before	After	% change	Before	After	% change
EB at Nicollet Ave	14.38%	16.00%	11.27%	14.61%	16.18%	10.78%
WB at Nicollet Ave	17.73%	15.40%	-13.18%	18.26%	16.24%	-11.06%
EB at Xerxes Ave	26.86%	22.03%	-17.97%	30.27%	24.38%	-19.47%
WB at Xerxes Ave	16.48%	15.49%	-5.99%	17.26%	16.33%	-5.37%
Total	19.33%	17.44%	-9.73%	20.76%	18.56%	-10.59%
	Weekday Midday (11 am-2 pm)			Saturday Midday (11 am-2 pm)		
	Before	After	% change	Before	After	% change
EB at Nicollet Ave	13.93%	14.86%	6.66%	12.93%	14.56%	12.61%
WB at Nicollet Ave	15.68%	14.97%	-4.51%	15.44%	15.48%	0.28%
EB at Xerxes Ave	17.72%	15.22%	-14.09%	13.56%	12.35%	-8.91%
WB at Xerxes Ave	14.50%	15.09%	4.07%	10.81%	13.51%	25.03%
Total	15.56%	15.05%	-3.30%	13.18%	13.89%	5.41%

Table Al-11: Chi-Square Test on Corridor Traffic Distribution

		Before	After	Total	Chi-Square	Value	D. F.	Significance
AM Peak Period (6:00-9:00 am)								
arterial	actual	7029	7375	14404				
	expected	6977	7427		Pearson	0.84210	1	0.35880 P>0.05
	distribution	11.5%	11.4%	11.5%	Continuity Corr.	0.82592	1	0.36346 P>0.05
freeway	actual	53884	57463	111347	Likelihood Ratio	0.84199	1	0.35883 P>0.05
	expected	53936	57411		Mantel-Haenzel	0.84209	1	0.35880 P>0.05
	distribution	88.5%	88.6%	88.5%				
AM Peak Hour (7:00-8:00 am)								
		Before	After	Total	Chi-Square	Value	D. F.	Significance
arterial	actual	3220	3528	6748				
	expected	3246	3502		Pearson	0.47810	1	0.48928 P>0.05
	distribution	14.1%	14.3%	14.2%	Continuity Corr.	0.46009	1	0.49758 P>0.05
freeway	actual	19683	21177	40860	Likelihood Ratio	0.47818	1	0.48925 P>0.05
	expected	19657	21203		Mantel-Haenzel	0.47809	1	0.48929 P>0.05
	distribution	85.9%	85.7%	85.8%				
Weekday Midday Period (11:00 am - 2:00 pm)								
		Before	After	Total	Chi-Square	Value	D. F.	Significance
arterial	actual	9821	9132	18953				
	expected	9662	9291		Pearson	6.27801	1	0.01222 P<0.05
	distribution	15.6%	15.1%	15.3%	Continuity Corr	6.2385	1	0.01250 P<0.05
freeway	actual	53282	51544	104826	Likelihood Ratio	6.27939	1	0.01221 P<0.05
	expected	53441	51385		Mantel-Haenzel	6.27796	1	0.01222 P<0.05
	distribution	84.4%	84.9%	84.7%				
PM Peak Period (3:00-6:00 pm)								
		Before	After	Total	Chi-Square	Value	D. F.	Significance
arterial	actual	14408	13525	27933				
	expected	13693	14240		Pearson	89.61486	1	0.00000 P<0.05
	distribution	19.3%	17.4%	18.4%	Continuity Corr.	89.48950	1	0.00000 P<0.05
freeway	actual	60148	64005	124153	Likelihood Ratio	89.60081	1	0.00000 P<0.05
	expected	60863	63290		Mantel-Haenzel	89.61427	1	0.00000 P<0.05
	distribution	80.7%	82.6%	81.6%				
PM Peak Hour (4:00-5:00 pm)								
		Before	After	Total	Chi-Square	Value	D.F.	Significance
arterial	actual	5335	4920	10255				
	expected	5048	5207		Pearson	39.97436	1	0.00000 P<0.05
	distribution	20.8%	18.6%	19.6%	Continuity Corr.	39.83517	1	0.00000 P<0.05
freeway	actual	20368	21592	41960	Likelihood Ratio	39.97391	1	0.00000 P<0.05
	expected	20655	21305		Mantel-Haenzel	39.97359	1	0.00000 P<0.05
	distribution	79.2%	81.4%	80.4%				
Saturday Midday (11:00 am - 2:00 pm)								
		Before	After	Total	Chi-Square	Value	D. F.	Significance
arterial	actual	7754	8345	16099				
	expected	7966	8133		Pearson	12.89567	1	0.00033 P<0.05
	distribution	13.2%	13.9%	13.5%	Continuity Corr.	12.83486	1	0.00034 P<0.05
freeway	actual	51079	51724	102803	Likelihood Ratio	12.89895	1	0.00033 P<0.05
	expected	50867	51936		Mantel-Haenzel	12.89556	1	0.00033 P<0.05
	distribution	86.8%	86.1%	86.5%				

Tables Al -10 and Al -11 provide a direct percent comparison and Chi-Square Test of average adjusted seasonal corridor traffic distribution on the arterial street system from before and after implementation of Modules 1 and 2. The corridor distribution of traffic results above shows very little support for the hypothesis that there has been an increase in the proportion of corridor traffic using the arterial street system. The maximum net system volume change, as shown on Table Al-l0, was a reduction from 20.76 to 18.56 percent, or 2.2 percent, during the 4:00 to 5:00 PM peak hour. During the AM Peak Period and AM Peak Hour, there was no change in proportion of corridor traffic on the arterial street system which experienced an average change of (+) 1.57% to (-) 1.43%. During the PM Peak Period and PM Peak Hour, there was a 9.73% and 10.59% decrease in the proportion of corridor traffic on the arterial street system. The proportion of corridor traffic on the arterial street system also decreased slightly by 3.30% during the Weekday Midday Period. These negative results are statistically significant as well. The one positive result is the proportion of corridor traffic on the arterial street system which increased by 5.41% during the Saturday Midday Period. This change is statistically significant at a 95% confidence level as determined by the chi-square test in Table Al-l 1.

A more reliable comparison of arterial/freeway system traffic pattern changes attributed to ICTM is expected with the before/after evaluation of Module 3.

MOE 1-3.1 - *Increase in screenline traffic volume in response to incident management plans.*

- Hypothesis *1-3.1* a - *There is an increase in traffic volumes at arteriaI screenline locations under freeway incident conditions.*

  This MOE and hypothesis is not addressed as part of the Module 1 and 2 evaluation. Complete incident management plans will be implemented as part of ICTM Module 4 with evaluation of their effects on arterial screenline traffic volumes included in the final report.

6. Summary of Results

The screenline traffic volume data evaluated in this test plan indicates there has been a general reduction in the utilization of the arterial street and freeway system in the I-494 corridor. Statistical tests indicate that peak period freeway screenline volumes have decreased significantly during the morning 6:00 to 9:00 AM and the evening 3↑00 to 6:00 PM time periods. Peak hour 7:00 to 8:00 AM traffic volumes have been shown to demonstrate no statistical change since implementation of Modules 1 and 2 whereas 4:00 to 5:00 PM peak hour freeway volumes have shown a significant decrease. Midday 11:00 AM to 2:00 PM freeway volumes adjusted for seasonal traffic variations demonstrated a similar significant decrease in volume after implementation of Modules 1 and 2. In contrast, Saturday freeway volumes adjusted for seasonal variations demonstrated a significant increase.

Statistical tests also indicate that corridor-wide total freeway and arterial street screenline volumes demonstrated similar volume reduction patterns as summarized above for T-494 except during the Saturday 1l:00 AM to 2:00 PM time period when corridor-wide screenline volumes were significantly less in total after implementation of Modules 1 and 2 even though I-494 freeway volumes were significantly greater. There is no change in the proportion of total corridor traffic on the arterial street system during peak traffic periods.

Freeway Traffic Volume	**Corridor Traffic Volume**
↓ Volumes have decreased significantly in 3 of 4 peak weekday traffic periods	↓ Volumes decreased significantly in 2 of 4 peak weekday traffic periods
↓ Midday volumes adjusted for seasonal variation decreased significantly	↓ Midday and Saturday volumes adjusted for seasonal variation decreased significantly
↑ Saturday volumes adjusted for seasonal variation increased significantly	
Utilization of Arterial Street Capacity	
- Arterial street system carried the same proportion of the total corridor volume during the AM Peak Hour ↓ Arterial street system carried 10.59% less of the total corridor volume during the PM Peak Hour	

The relative decrease in peak hour traffic volume conditions identified in the corridor does not affect the analysis conditions identified for qualitative freeway operating conditions, reported in Test Plan #2. On those days when freeway travel speed data was collected, I-494 actually demonstrated increased traffic levels compared to “before” implementation of Modules 1 and 2.

Sample Calculation
Seasonal Adjustment Volumes

	Actual Volumes	x	Seasonal Adjustment Factors	=	Average Annual Volumes
Before					
week 1 (August)	13,042		0.85		11,086
	13,042				11,086
After					
week 1 (April)	13,241		0.94		12,447
week 2 (April)	13,471		0.94		12,663
week 3 (May)	13,563		0.88		11.935
	13,425				12,348

Seasonal Adjustment Factors were applied to each 15-minute actual count. Average Annual Volumes were calculated using each adjusted 15-minute counts.

**1995 Metro Area 24-Hour Seasonal
Adjustment Factors for A.A.D.T.
Based on 3-Year Average***

Month	Week Day*	High Commute Red (09)	Commuter Shopper Blue (11)	Low Rec. Orange (17)	Moderate Rec. Green (14)
January 1	Tuesday	1.06	1.08	1.22	
	Wednesday	1.08	1.09	1.24	
	Thursday	1.06	1.06	1.20	
February 2	Tuesday	1.04	1.06	1.20	
	Wednesday	1.03	1.05	1.18	
	Thursday	1.01	1.03	1.16	
March 3	Tuesday	1.00	1.02	1.14	
	Wednesday	0.99	1.01	1.13	
	Thursday	0.97	0.99	1.09	
April 4	Tuesday	0.95	**0.97**	1.07	
	Wednesday	0.93	**0.95**	1.06	
	Thursday	0.93	**0.94**	1.03	
May 5	Tuesday	0.90	**0.93**	1.01	
	Wednesday	0.88	0.91	0.99	
	Thursday	0.87	0.89	0.95	
June 6	Tuesday	0.86	**0.91**	0.96	
	Wednesday	0.85	**0.90**	0.95	
	Tbursdav	0.84	**0.88**	0.91	
July 7	Tuesday	0.86	**0.92**	**0.95**	
	Wednesday	0.85	**0.90**	0.94	
	Tbursdav	0.84	**0.89**	0.91	
August 8	Tuesday	0.87	**0.92**	**0.95**	
	Wednesday	0.85	0.91	**0.93**	
	Thursday	0.84	0.89	0.90	
September 9	Tuesday	**0.89**	**0.94**	1.02	
	Wednesday	0.87	**0.92**	**0.99**	
	Thursday	0.86	**0.91**	**0.96**	
October 10	Tuesday	0.90	**0.95**	1.04	
	Wednesday	0.88	**0.93**	1.01	
	Thursday	0.88	0.92	0.98	
November 11	Tuesday	0.99	1.01	1.13	
	Wednesday	0.97	0.98	1.11	
	Thursday	0.95	0.96	1.07	
December 12	Tuesday	0.96	**0.99**	1.12	
	Wednesday	0.96	**0.98**	1.11	
	Thursday	0.95	0.96	1.08	

*Weekday indicates middle day of 48-hour counting period.
*3 Year average includes 1992 through 1994 ATR groups.

Test Plan No. 2 - Change in Corridor Operating Conditions.

1. Test Purpose

The purpose of this test plan is to evaluate how well the ICTM system responds to fluctuations in traffic flow and facilitates the use of available corridor capacity. This test involves a before/after comparison analysis of traffic-related measures of effectiveness related to travel time, ramp meter delay, and intersection operation. Travel time runs were conducted to evaluate the effects of ICTM on arterial and freeway system travel times/speeds, number of arterial vehicle stops, and stop time delay in the I-494 corridor. Freeway ramp meter queue lengths, ramp volume, and meter rate data were collected to identify changes in average queue delays at freeway entrance ramp meters. Intersection queue studies and turning movement counts assess the change in approach delays and occurrence of cycle failures at signalized arterial and ramp terminal intersections.

2. Schedule of Test Activities

Task	Before Data	After Data
Travel Time Studies	February 1994 - November 1995	April - May 1996
Ramp Queue Studies	August 1995	April - May 1996
Intersection Studies	August 1995	April - May 1996

3. Tabulated Data Collected

Tabulated travel time, vehicle stop and delay data; entrance ramp queue lengths, timing, and volume data; and intersection queue length, cycle failure, signal timing, and turning movement count data is available through the ICTM Project Manager and/or HNTB Corporation.

4. Analysis Methods

There are a total of five measures of effectiveness that address changes in operating conditions within the I-494 corridor.

MOE l-l.2 - *Decrease in travel time through the corridor.*

Travel time study data is used to assess the effectiveness of ICTM to improve traffic operations during normal traffic conditions. This MOE in particular determines the total amount of time necessary for motorists to travel through the test corridor. The analysis includes a comparison of travel time data collected before ICTM and after implementation of modules 1 and 2. The effectiveness of ICTM to improve traffic operations is supported by the project goal to decrease the average travel time through the corridor by 10% on the arterial street and freeway systems.

In addition to the project goal of decreasing travel time by l0%, statistical tests were conducted on the travel time data to identify any significant changes. Separate tests were conducted to identify statistical changes in travel time consistency and change in average travel time. Statistical analysis of travel time data includes a Levine's Test for Equality of Variances with a 95% confidence interval to test the consistency of travel times in the corridor and a t-test for Equality of Means with a 95% confidence interval to test the reduction in travel times in the corridor.

MOE *1-1.3 - Reduction in the number of arterial vehicle stops and delay within the corridor.*

Traffic data on the number of vehicle stops and delay on the arterial street system was collected for before and after implementation of modules 1 and 2. However since there were no ICTM principles implemented which directly impacted the arterial street system, no analysis was completed at this time. The components of ICTM affecting the arterial street system will be implemented in Module 3 and Module 4 and will be evaluated at that time. The vehicle stop and delay data collected after implementation of Modules 1 and 2 will be added to the before ICTM data files to provide a larger sample of baseline data for comparison to post Module 3 and Module 4 data.

MOE l-l.4 - *Reduction in queue delays on freeway entrance ramps.*

Freeway entrance ramp queue length, meter operation, and traffic volume data samples were collected to evaluate the delays experienced by motorists at I-494 entrance ramp meters. Entrance ramp queue delays are used to determine the effectiveness of ICTM to improve traffic operations within the corridor. The analysis includes a before/after cumulative comparison of the total vehicle delay per hour experienced during the AM and PM peak hours at eight sample ramp meter locations for modules 1 and 2. The effectiveness of ICTM to improve traffic operations within the corridor is supported by a 10% decrease in the total vehicle delay per hour experienced at sample no-ramp locations. The analysis does not include statistical testing.

MOE l-l.5 - *Reduction in queue delays at arterial intersections.*

Intersection queue delays are calculated using intersection queue lengths, turning movement, and signal timing data. Queue studies at arterial intersections were conducted for before and after implementation of modules 1 and 2. However since there were no ICTM principles implemented which directly impacted the arterial street system, no analysis was completed at this time. The components of ICTM affecting the arterial street system will be implemented in Module 3 and Module 4 and will be evaluated at that time. The intersection queue delay data collected after Modules 1 and 2 will be added to the before ICTM data files to provide a larger sample of baseline data for comparison to post Module 3 and Module 4 data.

MOE 1-2.1 - *Reduction in the number of cycle failures at arterial and ramp terminal intersections.*

Cycle failures are visually collected data samples used to assess the operation of traffic signals within the ICTM corridor. Since the operational test includes the implementation of adaptive signal control, traditional level of service analysis is not applicable in this evaluation. Cycle failure studies at arterial intersections were conducted for before and after implementation of modules 1 and 2. However since there were no ICTM principles implemented which directly impacted the arterial street system, no analysis was completed at this time. The components of ICTM affecting the arterial street system will be implemented in Module 3 and Module 4 and will be evaluated at that time. The intersection cycle failure data collected after Modules 1 and 2 will be added to the before ICTM data files to provide a larger sample of baseline data for comparison to post Module 3 and Module 4 data.

5. Results and Interpretations

MOE l-l.2 - *Decrease in travel time through the corridor.*

- Hypothesis l-l .2a - *Freeway travel times are more consistent for corresponding peak travel periods.*

Table A2-l: Minimum/Maximum Travel Times on the Freeway System (min)

	AM Peak Period (6:00 - 9:00 am)								AM Peak Hour (7:30 - 8:30 am)						
Route	Before			After			% change	Route	Before			After			% change
	min	max	range	min	max	range	in range		min	max	range	min	max	range	in range
I-494 EB	7.5	12.0	4.6	7.6	10.5	2.9	-36.26%	I-494 EB	8.3	12.0	3.8	8.5	10.2	1.8	-53.33%
I-494 WB	7.9	22.1	14.2	7.8	14.3	6.5	-54.12%	I-494 WB	10.4	22.1	11.7	8.8	14.3	5.5	-53.14%
Total	15.4	34.1	18.7	15.5	24.9	9.4	-49.78%	Total	18.7	34.1	15.4	17.3	24.5	7.2	-53.19%

	PM Peak Period (3:00 - 6:00 pm)								PM Peak Hour (4:30 - 5:30 pm)						
Route	Before			After			% change	Route	Before			After			% change
	min	max	range	min	max	range	in range		min	max	range	min	max	range	in range
I-494 EB	8.1	13.0	4.9	8.3	12.7	4.4	-9.25%	I-494 EB	10.7	13.0	2.3	8.3	12.7	4.4	89.93%
I-494 WB	8.0	13.5	5.5	7.6	11.4	3.8	-30.58%	I-494 WB	10.2	13.5	3.3	7.6	9.9	2.3	-29.44%
Total	16.2	26.5	10.3	15.9	24.1	8.2	-20.52%	Total	20.9	26.5	5.6	15.9	22.6	6.7	19.94%

	Midday Period (10:30 am - 1:30 pm)								Saturday Midday (10:30 am - 1:30 pm)						
Route	Before			After			% change	Route	Before			After			% change
	min	max	range	min	max	range	in range		min	max	range	min	max	range	in range
I-494 EB	7.9	8.6	0.8	7.3	8.3	1.0	32.61%	I-494 EB	7.6	8.1	0.5	7.4	8.5	1.1	125.00%
I-494 WB	7.7	8.5	0.8	7.4	8.5	1.0	31.91%	I-494 WB	7.8	8.6	0.8	7.7	8.3	0.6	-28.00%
Total	15.5	17.1	1.6	14.7	16.7	2.1	32.26%	Total	15.4	16.7	1.3	15.1	16.7	1.7	26.92%

Table A2-2: Levine's Test for Equality of Variance

	Number of Cases	Mean (sec)	Standard Deviation	SE of Mean	Mean Difference	F	P	Result
AM Peak Period (6-9 am)								
I-494 EB								
Before ICTM	11	528.0000	75.588	22.791				
AfterModule 1 and 2	11	530.4545	61.959	18.681	-2.4545	0.000	0.985	P > 0.05
I-494 WB								
Before ICTM	II	762.1818	283.662	85.527				
AfterModule 1 and 2	10	624.4000	126.429	29.980	137.7818	8.019	0.011	P > 0.05
PM Peak Period (3-6 pm}								
I-494 EB								
Before ICTM	13	621.7692	95.336	26.44 I				
After Module1 and 2	11	644.0000	96.777	29.179	-22.2308	0.147	0.705	P > 0.05
I-494 WB								
Before ICTM	12	586.4167	109.380	31.575				
AfterModule 1 and 2	10	540.9000	75.694	23.937	45.5167	1.858	0.188	P> 0.05

Table A2-1 provides a comparison of the range of minimum and maximum travel times (seconds) on the freeway system before and after the implementation of Modules 1 and 2. Table A2-2 provides statistical results of Levine's Test for Equality of Variance of travel times.

<u>AM Peak Period</u> - The results above show an increase in the consistency (decrease in standard deviation) of travel time during the 6:00 - 9:00 AM Peak Period due to the implementation of Modules 1 and 2. On eastbound I-494, the standard deviation of travel time decreased from 75.59 to 61.96 seconds. On westbound I-494, the standard deviation of travel time decreased from 283.66 to 126.43 seconds. Statistical results indicate the change in standard deviation (consistency) of travel time on WB I-494 during the AM Peak Period is significant within a 95% confidence interval. The change in standard deviation of travel time on EB I-494, although positive, is not statistically significant. Of the comparisons addressing the Evaluation Goals, 2 of 2 results support the hypothesis. Statistical comparison results in 1 of 2 support the hypothesis and 1 having no statistical significance.

<u>PM Peak Period</u> - The results for the 3:00 - 6:00 PM Peak Period show mixed results in the consistency (change in standard deviation) of travel time due to the implementation of Modules 1 and 2. On eastbound I-494, the standard deviation of travel time increased slightly from 95.34 to 96.77 seconds. However, statistical

tests indicate this increase is not significant. On westbound I-494, the standard deviation of travel time decreased from 109.38 to 75.694 seconds. Statistical results indicate the change in standard deviation (consistency) of travel time on WB I-494 during the PM Peak Period, although positive, is also not significant within a 95% confidence interval. Of the comparisons addressing the Evaluation Goals, 1 of 2 results support the hypothesis and 1 contradicts the hypothesis. Statistical comparison results in 2 of 2 having no statistical significance.

Weekend and Saturday Midday - Results for the Weekday and Saturday Midday time periods indicate there is an overall decrease in the consistency of travel times, however these changes are not considered attributable to ICTM since the components of Modules 1 and 2 are not intended to address freeway operations during the off peak periods. There were no statistical tests conducted for the Weekday and Saturday Midday time periods.

- Hypothesis 1-1.2b - *Arterial travel times are more consistent for corresponding peak travel periods.*

Tables A2-3 to A2-8 provide summaries of average travel time on the arterial street system. Average travel times and delay on the parallel and perpendicular arterial street system have changed ranging from a total increase of 3.8 minutes in the PM Peak Hour to a decrease of 4.2 minutes in the AM Peak Hour. The data collected as “after” data will be used as the before data base for the evaluation of Module 3. This should provide a more reliable comparison of arterial street operations as the “after” data was collected during a continuous three week time period which was not the case with collection of “before” travel time data. The components of ICTM affecting the arterial street system will be implemented in Module 3 and Module 4 and will be evaluated at that time.

Table A2-3: ICTM Arterial Street System Travel Characteristics - AM Peak Period (6:00-9:00 am)

Street	Travel Time (min)			Stop Time Delay (min)			% of Travel Time Stopped			Number of Stops			Avg Delay per Stop (sec)		
	Before	After	Diff	Before	After	Diff	Before	After	Diff	Before	After	Diff	Before	After	Diff
PARALLEL ARTERIAL															
76th Street EB	8.1	7.2	-0.8	1.0	0.8	-0.2	12.6%	10.8%	-1.8%	4.4	4.1	-0.3	13.8	11.5	-2.4
77th Street EB	2.9	3.2	0.2	0.3	0.3	0.0	11.7%	9.9%	-1.8%	1.3	1.2	-0.1	15.8	15.6	-0.3
79th Street EB	5.8	5.7	-0.1	1.0	1.1	0.1	17.2%	19.7%	2.5%	2.8	3.1	0.3	21.4	21.6	0.2
80th/82nd Street EB	8.7	7.9	-0.8	1.4	1.2	-0.2	16.6%	15.3%	-1.2%	5.1	5.4	0.3	17.0	13.4	-3.6
Eastbound	25.5	23.9	-1.6	3.8	3.4	-0.4	14.9%	14.3%	-0.6%	13.6	13.8	0.2	16.8	14.9	-1.9
76th Street WB	8.4	7.5	-0.8	1.1	1.0	-0.2	13.5%	12.6%	-0.8%	3.4	4.2	0.8	19.9	13.6	-6.2
77th Street WB	3.0	3.1	0.1	0.4	0.3	-0.1	12.0%	9.3%	-2.7%	1.6	1.3	-0.3	13.4	13.5	0.0
79th Street WB	5.9	5.7	-0.2	1.2	1.1	-0.2	20.6%	18.5%	-2.1%	2.6	3.0	0.4	28.3	21.1	-7.2
80th/82nd Street WB	9.2	8.9	-0.3	1.8	2.0	0.2	19.8%	22.5%	2.6%	5.3	5.9	0.6	20.7	20.4	-0.3
Westbound	26.5	25.3	-1.2	4.5	4.3	-0.2	17.1%	17.0%	-0.1%	12.9	14.4	1.5	21.1	18.0	-3.2
SUBTOTAL	52.0	49.3	-2.8	8.3	7.7	-0.6	16.0%	15.7%	-0.3%	26.5	28.2	1.7	18.9	16.4	-2.4
PERPEDICULAR ARTERIAL															
France Ave NB	4.3	4.4	0.1	0.9	1.1	0.2	20.7%	24.8%	4.2%	2.0	2.5	0.5	26.8	26.2	-0.6
Penn Ave NB	6.6	5.8	-0.8	1.4	0.9	-0.5	21.9%	16.0%	-5.9%	4.1	3.9	-0.2	21.1	14.3	-6.8
Lyndale Ave NB	4.2	4.0	0.1	0.4	0.4	0.1	8.3%	9.7%	1.4%	2.1	2.5	0.4	10.1	10.0	-0.1
Nicollet Ave NB	5.0	4.5	-0.4	0.4	0.2	-0.3	9.0%	3.8%	5.2%	2.4	1.8	-0.6	11.2	5.7	-5.5
Portland Ave NB	5.6	4.6	-1.0	0.7	0.2	-0.5	11.9%	4.0%	-7.9%	3.3	1.4	-1.9	12.2	8.0	-4.2
12th Ave NB	6.5	6.4	-0.2	0.8	0.7	-10.1	12.1%	10.7%	1.4%	3.7	4.4	0.7	12.8	9.3	-3.6
24th Ave NB	1.2	1.5	0.3	0.2	0.5	0.3	13.6%	29.5%	15.9%	1.0	1.4	0.4	9.9	19.5	9.6
Northbound	33.1	31.6	-1.8	4.8	3.9	-0.8	14.2%	12.5%	-1.8%	18.6	17.9	-0.7	15.4	13.2	-2.2
France Ave SB	4.1	4.0	-0.2	0.7	0.6	-0.1	16.6%	14.5%	-2.2%	2.3	2.4	0.1	17.9	14.3	-3.6
Penn Ave SB	6.0	5.6	-0.3	0.9	0.8	-0.1	15.4%	13.7%	-1.7%	3.4	3.2	-0.2	16.2	14.5	-1.7
Lyndale Ave SB	4.3	4.7	0.4	0.5	0.7	0.3	10.6%	15.5%	4.9%	2.4	3.5	1.1	11.5	12.5	1.0
Nicollet Ave SB	4.7	5.0	0.7	0.7	0.3	0.1	4.5%	5.9%	1.4%	1.9	1.6	-0.3	6.7	11.0	4.3
Portland Ave SB	5.0	4.7	-0.4	0.3	0.2	-0.1	5.4%	3.7%	-1.7%	2.5	1.8	-0.7	6.5	5.7	-0.8
12th Ave SB	6.0	5.8	-0.1	0.3	0.3	0.0	5.1%	5.9%	0.8%	3.0	5.0	2.0	6.1	4.1	-1.9
24th Ave SB	1.2	1.2	0.0	0.1	0.1	0.0	10.5%	10.7%	0.1%	0.9	0.7	-0.2	8.2	10.7	2.5
Southbound	31.3	30.9	-0.4	3.0	3.0	0.0	9.5%	9.7%	0.2%	16.4	18.2	1.8	10.9	9.9	-1.0
SUBTOTAL	64.7	62.5	-2.2	7.7	6.9	-0.8	11.9%	11.1%	-0.8%	35.0	36.1	1.1	13.3	11.5	-1.7
TOTAL	116.8	111.8	-5.0	16.1	14.7	-1.4	13.8%	13.1%	-0.6%	61.5	64.3	2.8	15.7	13.7	-2.0

Table A2-4: ICTM Arterial Street System Travel Characteristics - AM Peak Hour (7:30-8:30 am)

Street	Travel Time (min)			Stop Time Delay (min)			% of Travel Time Stopped			Number of Stops			Avg Delay per Stop (sec)		
	Before	After	Diff	Before	After	Diff	Before	After	Diff	Before	After	Diff	Before	After	Diff
PARALLEL ARTERIAL															
76th Street EB	8.6	7.9	-0.6	1.4	1.2	-0.2	16.2%	15.6%	-0.6%	4.7	5.6	0.9	17.7	13.2	-4.5
77th Street EB	3.0	3.1	0.0	0.4	0.3	- 0.1	14.5%	10.5%	-4.0%	1.3	0.8	-0.5	20.2	24.1	3.9
79th Street EB	5.9	5.7	-0.2	1.1	1.3	0.2	18.4%	22.7%	4.3%	3.0	3.6	0.6	21.7	21.4	-0.3
80th/82nd Street EB	9.0	8.1	-0.9	1.7	1.5	-0.2	18.6%	18.5%	-0.1%	5.8	6.4	0.6	17.3	14.1	-3.2
Eastbound	26.5	24.8	-1.7	4.6	4.3	-0.2	17.3%	17.5%	0.2%	14.8	16.4	1.6	18.6	15.9	-2.7
76th Street WB	8.7	8.1	-0.6	1.3	1.1	-0.3	15.4%	13.2%	-2.2%	3.7	6.2	2.5	21.7	10.3	-11.4
77th Street WB	2.8	3.6	0.7	0.4	0.5	-0.2	10.8%	14.5%	3.8%	1.8	1.8	0.0	10.2	17.2	7.0
79th Street WB	6.3	5.9	-0.3	1.5	1.4	-0.1	24.5%	23.8%	-0.6%	3.2	3.0	-0.2	28.8	28.3	-0.5
80th/82nd Street WB	9.9	9.2	-0.7	2.5	2.1	0.3	24.8%	23.1%	-1.7%	6.0	6.2	0.2	24.5	20.6	-3.9
Westbound	27.7	26.8	-1.0	5.6	5.1	-0.5	20.3%	19.1%	-1.2%	14.7	17.2	2.5	23.0	17.9	-5.1
SUBTOTAL	54.2	51.5	-2.7	10.2	9.5	-0.8	18.8%	18.4%	-0.5%	29.5	33.6	4.1	20.8	16.9	-3.9
PERPEDICULAR ARTERIAL															
France Ave NB	4.7	4.5	-0.2	1.2	1.2	0.0	25.8%	27.1%	1.3%	2.2	2.5	0.3	33.4	29.6	-3.8
Penn Ave NB	6.7	5.7	-1.0	1.6	1.0	-0.6	23.8%	18.2%	-5.6%	4.0	3.6	-0.4	23.9	17.2	-6.7
Lyndale Ave NB	4.2	4.3	0.1	0.3	0.4	0.1	8.0%	9.0%	1.0%	2.3	2.5	0.2	8.8	9.4	0.5
Nicollet Ave NB	5.1	4.5	-0.6	0.6	0.3	-0.3	11.4%	5.9%	-5.6%	2.3	1.8	-0.5	15.3	8.9	-6.4
Portland Ave NB	5.4	4.5	-0.9	0.6	0.2	-0.3	10.3%	4.7%	-5.7%	2.8	1.2	-1.6	11.9	10.6	-1.3
12th Ave NB	6.4	6.4	-0.1	0.9	0.6	-0.3	14.1%	10.1%	-4.1%	4.0	4.4	0.4	13.7	8.7	-4.9
24th Ave NB	1.4	1.8	0.4	0.3	0.6	0.4	20.5%	35.7%	15.1%	1.3	1.8	0.5	12.9	21.4	8.5
Northbound	34.0	31.8	-2.2	5.5	4.4	-1.1	16.1%	13.9%	-2.2%	18.9	17.8	-1.1	17.4	14.9	-2.5
France Ave SB	3.9	4.0	0.2	0.4	0.6	0.2	10.0%	14.1%	4.1%	1.7	2.7	1.0	13.6	12.6	-1.0
Penn Ave SB	6.0	5.9	0.0	0.9	1.0	0.1	14.9%	16.0%	1.2%	3.4	3.8	0.4	15.6	15.0	-0.6
Lyndale Ave SB	4.2	4.8	0.6	0.5	0.8	0.4	10.8%	17.3%	6.4%	2.0	3.7	1.7	13.7	13.5	-0.2
Nicollet Ave SB	4.8	5.0	0.2	0.3	0.4	0.1	6.4%	7.2%	0.8%	1.8	1.6	-0.2	10.1	13.4	3.3
Portland Ave SB	5.0	4.7	-0.3	0.3	0.2	-0.1	5.0%	3.9%	-1.1%	2.5	2.3	-0.2	6.0	4.8	-1.2
12th Ave SB	5.8	6.1	0.2	0.2	0.4	0.1	4.2%	6.4%	2.3%	3.0	6.0	3.0	4.9	3.9	-1.0
24th Ave SB	1.3	1.2	-0.1	0.2	0.1	-0.1	17.6%	7.4%	-10.3%	1.2	0.6	-0.6	11.5	8.7	-2.8
Southbound	31.0	31.7	0.7	2.8	3.4	0.6	8.9%	10.6%	1.7%	15.6	20.7	5.1	10.6	9.8	-0.8
SUBTOTAL	64.9	63.5	-1.5	8.2	7.8	-0.5	12.7%	12.3%	-0.4%	34.5	38.5	4.0	14.3	12.1	-2.2
TOTAL	119.1	115.0	-4.1	18.5	17.2	-1.2	15.5%	15.0%	-0.5%	64.0	72.1	8.1	17.3	14.4	-3.0

Table A2-5: ICTM Arterial Street System Travel Characteristics – Weekday Midday (10:30 am -1:30pm)

Street	Travel Time (min)			Stop Time Delay (min)			% of Travel Time Stopped			Number of Stops			Avg Delay per Stop (sec)		
	Before	After	Diff	Before	After	Diff	Before	After	Diff	Before	After	Diff	Before	After	Diff
PARALLEL ARTERIAL															
76th Street EB	8.0	7.7	-0.3	1.1	1.1	0.1	13.4%	14.6%	1.2%	3.5	3.9	0.4	18.4	17.3	-1.1
77th Street EB	2.9	3.1	0.2	0.3	0.2	-0.1	9.0%	6.7%	-2.4%	0.9	1.6	0.7	17.4	7.7	-9.8
79th Street EB	6.3	6.0	-0.4	1.1	1.2	0.1	18.1%	20.6%	2.5%	2.8	3.2	0.4	24.6	23.0	-1.6
80th/82nd Street EB	8.0	8.2	0.2	1.1	1.4	0.3	13.3%	16.5%	3.1%	4.4	5.6	1.2	14.6	14.5	-0.1
Eastbound	25.2	24.9	-0.3	3.6	3.9	0.4	14.1%	15.7%	1.6%	11.6	14.3	2.7	18.4	16.4	-2.0
76th Street WB	8.3	8.0	-0.2	1.3	1.4	0.0	16.0%	17.0%	1.1%	4.5	4.8	0.3	17.6	17.1	-0.5
77th Street WB	3.3	3.4	0.2	0.6	0.5	-0.1	17.3%	14.4%	-2.9%	1.6	1.6	0.0	21.2	18.5	-2.7
79th Street WB	6.0	5.6	-0.4	0.8	0.9	0.1	13.1%	15.9%	2.8%	2.8	3.1	0.3	16.9	17.3	0.4
80th/82nd Street WB	9.7	9.2	-0.5	2.4	2.2	-0.2	24.9%	23.6%	-1.3%	6.1	6.4	0.3	23.7	20.3	-3.4
Westbound	27.2	26.2	-1.0	5.1	4.9	-0.2	18.7%	18.8%	0.1%	15.0	15.9	0.9	20.3	18.5	-1.8
SUBTOTAL	52.4	51.1	-1.3	8.6	8.8	0.2	16.5%	17.3%	-0.8%	26.6	30.2	15.6	19.5	17.5	-1.9
PERPEDICULAR ARTERIAL															
France Ave NB	4.7	4.5	-0.2	1.3	1.2	-0.1	28.3%	27.0%	1.3%	3.0	2.1	-0.9	26.6	34.7	8.1
Penn Ave NB	6.9	6.3	-0.6	1.5	1.3	-0.3	22.4%	20.1%	-2.3%	4.5	3.9	-0.6	20.6	19.6	-1.1
Lyndale Ave NB	4.8	5.8	1.0	0.7	1.3	0.6	15.0%	22.3%	7.3%	2.7	4.9	2.2	16.1	15.9	-0.2
Nicollet Ave NB	5.4	5.8	0.5	0.4	0.7	0.3	7.6%	11.6%	3.9%	2.6	2.5	-0.1	9.4	16.2	6.8
Portland Ave NB	6.1	5.9	-0.2	1.2	0.3	-0.9	19.5%	4.2%	-15.2%	3.2	3.0	-0.2	22.4	5.0	-17.3
12th Ave NB	6.3	6.2	-0.1	0.8	0.6	-0.1	12.0%	10.3%	-1.7%	3.4	4.8	1.4	13.3	8.0	-5.3
24th Ave NB	1.4	1.4	0.0	1.2	0.3	-0.9	90.5%	24.2%	-66.2%	1.1	1.2	0.1	67.3	16.9	-50.4
Northbound	35.6	36.1	0.5	7.2	5.7	-1.5	20.2%	15.8%	-4.4%	20.5	22.4	1.9	21.1	15.3	-5.8
France Ave SB	4.9	4.0	-0.8	1.3	0.8	-0.5	26.5%	20.6%	-5.8%	3.8	1.9	-1.9	20.4	26.4	5.9
Penn Ave SB	6.7	6.3	-0.4	1.4	1.0	-0.4	20.9%	16.3%	-4.6%	5.1	4.2	-0.9	16.5	14.6	-1.9
Lyndale Ave SB	5.7	6.2	0.4	1.4	1.7	0.3	23.8%	26.9%	3.2%	4.7	4.8	0.1	17.3	20.7	3.4
Nicollet Ave SB	4.5	5.1	0.6	0.2	0.3	0.1	3.4%	5.0%	1.5%	1.1	4.5	0.4	8.5	10.1	1.6
Portland Ave SB	4.9	5.6	0.6	0.2	0.5	0.3	4.7%	9.1%	4.3%	1.8	2.7	0.9	7.8	11.2	3.4
12th Ave SB	6.1	6.0	-0.2	0.6	0.7	0.1	9.5%	11.6%	2.1%	4.0	5.3	1.3	8.8	7.9	-0.9
24th Ave SB	1.2	1.5	0.3	0.2	0.4	0.2	13.6%	25.6%	11.9%	0.8	1.5	0.7	12.1	15.4	3.3
Southbound	34.1	34.6	0.5	5.2	5.4	0.2	15.2%	15.5%	0.2%	21.3	21.9	0.6	14.6	14.7	0.0
SUBTOTAL	69.7	70.7	1.0	12.4	11.0	1.3	17.8%	15.6%	-2.1%	41.8	44.3	2.5	17.8	15.0	-2.8
TOTAL	122.1	121.8	-0.4	121.0	19.9	-1.1	17.2%	16.3%	-0.9%	68.4	74.5	6.1	18.4	16.0	-2.4

Table A2-6: ICTM Arterial Street System Travel Characteristics – PM Peak Period (3:00 pm - 6:00 pm)

Street	Travel Time (min)			Stop Time Delay (min)			% of Travel Time Stopped			Number of Stops			Avg Delay per Stop (sec)		
	Before	After	Diff	Before	After	Diff	Before	After	Diff	Before	After	Diff	Before	After	Diff
PARALLEL ARTERIAL															
76th Street EB	8.8	8.2	-0.6	1.7	1.1	-0.6	19.3%	13.7%	-5.5%	5.4	4.9	-0.5	18.9	13.8	-5.1
77th Street EB	3.1	3.4	0.3	0.4	0.6	0.2	12.6%	17.1%	4.5%	1.3	1.9	0.6	18.1	18.5	0.4
79th Street EB	6.2	6.4	0.2	1.2	1.3	0.1	19.3%	20.5%	1.2%	3.3	3.2	-0.1	21.8	24.6	2.8
80th/82nd Street EB	9.1	9.2	0.2	1.7	1.8	0.1	18.5%	19.1%	0.6%	5.9	6.8	0.9	17.1	15.5	-1.6
Eastbound	27.2	27.3	0.1	5.0	4.8	-0.2	18.3%	17.6%	-0.7%	15.9	16.8	0.9	18.8	17.1	-1.7
76th Street WB	8.3	8.3	0.0	1.4	1.5	0.1	17.4%	18.8%	1.3%	4.6	4.0	-0.6	18.8	23.2	4.4
77th Street WB	3.5	3.8	0.2	0.7	0.8	0.0	20.9%	20.1%	-0.8%	1.9	2.2	0.3	23.3	20.6	-2.7
79th Street WB	5.7	5.8	0.2	0.8	0.8	0.0	13.5%	13.5%	0.0%	2.6	3.5	0.9	17.6	13.5	-4.2
80th/82nd Street WB	10.2	9.9	-0.3	3.1	2.6	-0.5	30.5%	26.9%	-3.6%	6.5	6.3	-0.2	28.7	25.2	-3.5
Westbound	27.7	27.7	0.0	6.1	5.7	-0.3	21.9%	20.7%	-1.1%	15.6	16.0	0.4	23.3	21.5	-1.8
SUBTOTAL	54.9	55.0	0.1	11.0	10.5	-0.5	20.1%	19.1%	-0.9%	31.5	32.8	1.3	21.0	19.3	-1.8
PERPEDICULAR ARTERIAL															
France Ave NB	4.3	4.3	0.1	0.9	1.1	0.2	22.2%	25.9%	3.7%	2.1	2.0	-0.1	27.1	33.7	6.6
Penn Ave NB	6.9	7.0	0.1	1.6	1.8	0.1	23.6%	25.4%	1.8%	4.6	4.1	-0.5	21.3	26.0	4.7
Lyndale Ave NB	4.6	5.8	1.2	0.5	1.2	0.7	11.2%	20.9%	9.7%	2.2	3.9	1.7	14.0	18.7	4.6
Nicollet Ave NB	5.7	5.8	0.1	0.8	0.8	0.0	14.2%	13.5%	-0.7%	2.6	2.0	-0.6	18.6	21.4	4.7
Portland Ave NB	6.2	5.8	-0.4	1.1	0.5	-0.6	17.8%	8.7%	-9.1%	3.7	2.7	-1.0	18.0	11.2	-6.8
12th Ave NB	6.7	6.6	-0.1	0.8	0.8	0.0	12.4%	12.2%	-0.2%	4.7	5.6	0.9	10.6	8.6	-2.0
24th Ave NB	1.5	1.5	0.1	0.3	0.4	0.1	18.9%	23.1%	4.2%	1.3	1.2	-0.1	12.8	17.7	4.9
Northbound	35.8	36.8	1.0	6.1	6.6	0.4	17.1%	17.8%	0.7%	21.2	21.5	0.3	17.3	18.3	1.0
France Ave SB	5.4	5.0	-0.5	1.6	1.3	-0.3	29.4%	27.1%	-2.3%	4.2	2.6	-1.6	22.8	31.0	8.2
Penn Ave SB	6.8	6.2	-0.6	1.5	1.0	-0.6	22.4%	15.4%	-6.9%	4.8	4.0	-0.8	19.0	14.3	-4.7
Lyndale Ave SB	5.8	6.7	0.9	1.3	1.9	0.6	22.8%	28.2%	5.4%	4.3	5.2	0.9	18.3	21.8	3.4
Nicollet Ave SB	5.1	5.4	0.3	0.4	0.4	0.0	7.0%	6.9%	-0.2%	2.1	2.0	-0.1	10.2	11.2	0.9
Portland Ave SB	5.4	5.7	0.3	0.5	0.5	0.0	8.8%	8.1%	-0.6%	2.3	2.9	0.6	12.3	9.5	-2.8
12th Ave SB	6.1	5.8	-0.3	0.4	0.5	0.0	7.0%	8.2%	1.2%	3.4	4.2	0.8	7.6	6.8	-0.8
24th Ave SB	1.5	1.7	0.2	0.4	0.6	0.2	23.5%	34.0%	10.5%	1.5	1.4	-0.1	14.1	24.9	10.9
Southbound	36.1	36.4	0.3	6.0	6.1	0.0	16.7%	16.7%	-0.1%	22.6	22.3	-0.3	16.0	16.3	0.3
SUBTOTAL	72.0	73.3	1.3	12.2	12.6	0.5	16.9%	17.2%	0.3%	43.8	43.8	0.0	16.7	17.3	0.6
TOTAL	126.9	128.2	1.3	23.2	23.1	0.0	18.3%	18.1%	-0.2%	75.3	76.6	1.3	18.5	18.1	-0.3

Table A2-7: ICTM Arterial Street System Travel Characteristics – PM Peak Hour (4:30 pm - 5:30 pm)

Street	Travel Time (min)			Stop Time Delay (min)			% of Travel Time Stopped			Number of Stops			Avg Delay per Stop (sec)		
	Before	After	Diff	Before	After	Diff	Before	After	Diff	Before	After	Diff	Before	After	Diff
PARALLEL ARTERIAL															
76th Street EB	8.1	9.2	1.1	2.2	1.8	-0.5	27.5%	19.0%	-8.5%	6.0	6.4	0.4	22.3	16.5	-5.8
77th Street EB	3.1	3.6	0.5	0.4	0.7	0.3	12.7%	18.7%	5.9%	1.2	1.8	0.6	19.8	22.2	2.4
79th Street EB	6.4	6.2	-0.1	1.3	1.1	-0.2	20.8%	17.4%	-3.4%	3.4	3.0	-0.4	23.4	21.8	-1.6
80th/82nd Street EB	9.7	9.5	-0.2	2.1	1.9	-0.2	21.1%	19.9%	-1.8%	6.3	7.2	0.9	20.1	15.7	-4.4
Eastbound	27.3	28.5	1.2	6.1	5.4	-0.7	22.2%	18.9%	-3.3%	16.9	18.4	1.5	21.5	17.6	-3.9
76th Street WB	7.0	8.5	1.5	1.3	1.9	0.5	19.1%	22.0%	2.9%	4.2	4.2	0.0	19.1	26.6	7.5
77th Street WB	3.7	4.0	0.3	0.9	0.9	0.1	23.2%	22.9%	-0.3%	2.0	2.0	0.0	25.8	27.3	1.6
79th Street WB	5.8	5.9	0.0	1.0	0.9	-0.1	16.5%	14.5%	-1.9%	3.4	3.6	0.2	16.9	14.2	-2.7
80th/82nd Street WB	10.3	10.7	0.4	3.2	3.5	0.3	31.1%	32.3%	1.2%	6.5	6.4	-0.1	29.6	32.5	2.8
Westbound	26.8	29.0	2.2	6.4	7.1	0.7	23.7%	24.4%	0.7%	16.1	16.2	0.1	23.7	26.3	2.5
SUBTOTAL	54.1	57.6	3.4	12.4	12.5	0.1	23.0%	21.7%	-1.3%	33.0	34.6	1.6	22.6	21.7	-0.9
PERPEDICULAR ARTERIAL															
France Ave NB	4.0	4.0	0.0	0.7	0.9	0.2	16.9%	22.6%	5.7%	2.0	1.2	-0.8	20.4	45.0	24.7
Penn Ave NB	8.1	8.1	0.0	2.2	2.3	0.2	27.2%	29.3%	2.1%	6.1	5.2	-0.6	22.5	26.9	4.4
Lyndale Ave NB	7.3	5.7	1.4	0.3	1.3	1.0	7.1%	23.5%	16.4%	1.0	3.3	2.3	18.0	24.2	6.2
Nicollet Ave NB	5.7	5.8	0.1	0.9	0.7	-0.2	15.5%	12.6%	-2.9%	2.4	2.0	-0.4	22.0	21.9	-0.1
Portland Ave NB	6.8	6.1	-0.7	1.8	0.6	-1.0	23.0%	9.7%	-13.3%	4.0	3.3	-1.3	20.3	10.7	-9.6
12th Ave NB	6.7	6.6	-0.1	0.9	0.8	-0.2	14.0%	11.6%	-2.4%	4.8	5.8	1.0	11.8	8.0	-3.9
24th Ave NB	1.6	1.7	0.1	0.4	0.4	0.0	22.3%	23.0%	0.7%	1.5	1.7	0.2	14.5	13.9	-0.6
Northbound	37.1	37.9	0.8	6.9	7.0	0.1	18.6%	18.6%	0.0%	22.1	22.5	0.4	18.7	18.8	0.1
France Ave SB	5.9	5.6	-0.3	1.8	1.8	0.0	31.1%	32.6%	1.5%	4.8	2.6	-2.2	22.8	41.9	19.1
Penn Ave SB	7.3	6.2	-1.1	1.8	0.9	-0.9	24.5%	15.1%	-9.4%	5.2	3.4	-1.8	20.6	16.4	-4.2
Lyndale Ave SB	5.9	6.5	0.6	1.3	1.6	0.3	22.5%	24.9%	2.4%	4.0	5.8	1.8	19.9	16.8	-3.1
Nicollet Ave SB	5.1	5.4	0.3	0.5	0.4	-0.1	9.3%	7.4%	-1.8%	2.0	1.8	-0.2	14.3	13.4	-0.9
Portland Ave SB	5.7	5.9	0.3	0.6	0.6	0.0	10.0%	9.7%	-0.4%	2.8	3.5	0.7	12.1	9.8	-2.3
12th Ave SB	6.2	5.8	0.4	0.5	0.5	0.1	7.9%	9.4%	1.4%	3.8	4.7	0.9	7.8	7.0	-0.8
24th Ave SB	1.6	1.8	0.2	0.4	0.6	0.2	28.1%	36.3%	8.2%	1.3	1.6	0.3	20.2	24.3	4.1
Southbound	37.6	37.2	-0.4	6.9	6.5	-0.4	18.4%	17.6%	-0.8%	23.9	23.4	-0.5	17.3	16.8	-0.6
SUBTOTAL	74.7	75.1	0.4	13.8	13.6	0.2	18.5%	18.1%	-0.4%	46.0	45.9	-0.1	18.0	17.8	-0.3
TOTAL	128.9	132.6	3.8	26 .2	26.1	0.2	20.4%	19.7%	-0.7%	79.0	80.5	1.5	19.9	19.4	-0.5

Table A2-7: ICTM Arterial Street System Travel Characteristics – Saturday Midday (10:30 am - 1:30 pm)

Street	Travel Time (min)			Stop Time Delay (min)			% of Travel Time Stopped			Number of Stops			Avg Delay per Stop (sec)		
	Before	After	Diff	Before	After	Diff	Before	After	Diff	Before	After	Diff	Before	After	Diff
PARALLEL ARTERIAL															
76th Street EB	8.0	7.8	-0.2	1.3	1.0	-0.3	15.6%	12.5%	-3.1%	4.5	3.7	-0.8	16.7	15.8	-0.9
77th Street EB	3.0	3.6	0.5	0.4	0.3	0.0	12.3%	9.2%	-3.1%	1.2	1.8	0.6	18.8	10.9	-7.8
79th Street EB	5.8	5.9	0.1	0.9	1.2	0.3	15.0%	20.5%	5.5%	2.6	3.2	0.6	20.0	22.8	2.8
80th/82nd Street EB	7.6	8.2	0.6	0.9	1.1	0.2	12.0%	14.0%	2.0%	4.6	6.2	1.6	11.9	11.1	-0.8
Eastbound	24.4	25.5	1.0	3.4	3.7	0.3	13.9%	14.4%	0.4%	12.9	14.9	2.0	15.9	14.8	-1.1
76th Street WB	8.5	7.7	-0.8	1.8	1.2	-0.6	20.7%	15.5%	-5.1%	4.5	5.0	0.5	23.4	14.4	-9.1
77th Street WB	3.5	3.4	-0.2	0.7	0.7	0.0	19.2%	19.6%	0.4%	2.1	1.8	-0.3	19.4	22.1	2.6
79th Street WB	5.5	5.6	0.1	0.5	0.9	0.4	9.5%	16.1%	6.6%	2.2	3.7	1.5	14.2	14.6	0.4
80th/82nd Street WB	9.1	8.7	-0.4	2.3	1.6	0.7	25.1%	18.4%	-6.6%	4.7	5.2	0.5	29.0	18.5	-10.5
Westbound	26.6	25.4	-1.2	5.2	4.4	0.9	19.7%	17.2%	-2.5%	13.5	15.7	2.2	23.2	16.7	-6.6
SUBTOTAL	57.0	50.8	-0.2	8.6	8.0	-0.6	16.9%	15.8%	-1.1%	26.4	30.6	4.2	19.6	15.7	-3.9
PERPEDICULAR ARTERIAL															
France Ave NB	4.6	4.2	-0.4	1.2	0.9	-0.3	25.6%	21.5%	-4.1%	2.9	2.3	-0.6	24.4	23.7	-0.7
Penn Ave NB	7.0	6.0	-1.0	1.5	1.1	-0.4	21.7%	18.1%	-3.6%	4.4	3.3	-1.1	20.7	19.7	-1.0
Lyndale Ave NB	5.4	5.7	0.2	1.0	1.0	0.1	17.8%	18.4%	0.6%	3.8	4.7	0.9	15.3	13.3	-2.0
Nicollet Ave NB	5.6	6.0	0.4	0.7	0.6	-0.1	12.1%	10.5%	-1.6%	3.1	2.5	-0.6	13.1	15.0	1.9
Portland Ave NB	5.9	5.8	-0.1	0.7	0.5	-0.1	11.6%	9.4%	-2.2%	3.2	2.5	-0.7	12.9	13.1	0.2
12th Ave NB	6.5	6.7	0.2	0.7	0.9	0.2	11.0%	14.0%	3.0%	3.0	3.8	0.8	14.2	14.8	0.6
24th Ave NB	1.6	1.4	-0.2	0.4	0.4	0.0	26.5%	27.3%	0.8%	1.6	1.2	-0.4	15.6	18.5	2.9
Northbound	36.6	35.7	-0.9	6.2	5.5	-0.6	16.8%	15.4%	-1.4%	22.0	20.3	-1.7	16.8	16.3	-0.5
France Ave SB	4.6	4.5	-0.1	1.0	1.2	0.2	21.0%	26.4%	5.4%	2.9	2.5	-0.4	19.8	28.2	8.4
Penn Ave SB	6.7	6.5	-0.3	1.5	1.4	-0.1	22.9%	21.9%	-1.0%	4.4	4.2	-0.2	21.0	20.3	-0.7
Lyndale Ave SB	6.3	6.8	0.5	1.7	2.1	0.5	26.4%	31.3%	4.9%	4.9	5.5	0.6	20.2	23.1	2.9
Nicollet Ave SB	5.3	5.6	0.3	0.4	0.5	0.1	7.4%	9.1%	1.7%	2.6	2.2	-0.4	9.0	13.9	4.8
Portland Ave SB	5.6	5.4	-0.2	0.3	0.3	0.0	6.1%	6.3%	0.3%	3.1	2.7	-0.4	6.5	7.6	1.0
12th Ave SB	6.1	5.9	-0.2	0.4	0.5	0.1	6.9%	8.6%	1.7%	3.2	3.7	0.5	7.9	8.2	0.3
24th Ave SB	1.3	1.9	0.5	0.3	0.6	0.4	18.9%	34.8%	15.9%	0.7	2.0	1.3	21.9	19.3	-2.6
Southbound	35.9	36.5	0.6	5.6	6.7	1.2	15.5%	18.4%	2.9%	21.8	22.8	1.0	15.3	17.7	2.4
SUBTOTAL	72.5	72.2	-0.3	11.7	12.2	0.5	16.2%	16.9%	0.8%	43.8	43.1	0.7	16.0	17.0	1.0
TOTAL	123.5	123.0	-0.5	20.3	20.3	-0.1	16.5%	16.5%	0.0%	70.2	73.7	3.5	17.4	16.5	-0.9

- **Hypothesis** 1 - 1.2c - *There is a decrease in the average travel time through the ICTM corridor.*

Table A2-9: Average Freeway Travel Time (min)

	AM Peak Period (6:00-9:00 am)			AM Peak Hour (7:30-8:30 pm)		
	Before	After	% change	Before	After	% change
I-494 EB	8.8	8.8	0.47%	9.3	9.4	0.90%
I-494 WB	12.7	10.4	-18.08%	16.9	11.3	-32.74%
Total	21.5	19.2	-10.49%	26.1	20.7	-20.78%
	PM Peak Period (3:00-6:00 pm)			PM Peak Hour (4:30-5:30 pm)		
	Before	After	% change	Before	After	% change
I-494 EB	10.4	10.7	3.57%	11.7	10.7	-8.66%
I-494 WB	9.9	9.0	-9.32%	10.6	8.7	-17.56%
Total	20.3	19.7	-2.74%	22.3	19.4	-12.89%
	Weekday Midday (10:30 am-1:30 pm)			Saturday Midday (10:30 am-1:30 pm)		
	Before	After	% change	Before	After	% change
I-494 EB	8.2	7.9	-3.74%	7.9	8.1	2.77%
I-494 WB	8.0	7.8	-2.02%	8.1	7.9	-1.65%
Total	16.2	15.7	-2.89%	16.0	16.0	0.53%

Table A2-10: t-test for Equality of Means

	t-value	df	2-Tail Sig	SE of Diff	95% Confidence Interval for Diff.	
AM Peak Period (6-9 am)						
I-494 EB						
Equal	-0.08	20	0.934	29.469	-63.940	59.031
Unequal	-0.08	19.26	0.934	29.469	-64.148	59.239
I-494 WB						
Equal	1.41	19	0.174	97.624	-66.596	342.160
Unequal	1.46	14.10	0.166	94.410	-64.760	340.323
PM Peak Period (3-6 pm)						
I-494 EB						
Equal	-0.57	22	0.578	39.326	-103.807	59.346
Unequal	-0.56	21.23	0.578	39.377	-104.140	59.679
I-494 WB						
Equal	1.11	20	0.280	40.976	-39.979	131.012
Unequal	1.15	19.43	0.265	39.623	-37.435	128.468

Table A2-11: Average Freeway Travel Speed (mph)

	AM Peak Period (6:00-9:00 am)			AM Peak Hour (7:30-8:30 pm)		
	Before	After	% change	Before	After	% change
I-494 EB	56.7	56.5	-0.35%	54.0	52.7	-2.41%
I-494 WB	45.4	50.4	11.01%	35.0	49.8	42.37%
Total	51.1	53.5	4.70%	44.5	51.3	15.19%
	PM Peak Period (3:00-6:00 pm)			PM Peak Hour (4:30-5:30 pm)		
	Before	After	% change	Before	After	% change
I-494 EB	49.2	48.8	-0.81%	44.4	48.8	9.91%
I-494 WB	51.8	55.5	7.14%	50.3	56.3	11.85%
Total	50.5	52.2	3.27%	47.4	52.5	10.94%
AM/PM Total	50.8	52.8	3.94%	45.9	51.9	13.07%
	Weekday Midday (10:30 am-1:30 pm)			Saturday Midday (10:30 am-1:30 pm)		
	Before	After	% change	Before	After	% change
I-494 EB	58.4	60.8	4.11%	60.2	58.9	-2.16%
I-494 WB	59.3	60.7	2.36%	58.8	60.1	2.21%
Total	58.9	60.8	3.23%	59.5	59.5	0.00%

Tables A2-9 and A2- 10 provide comparisons of the average travel times and statistical results from t-tests for Equality of Means of travel times on the freeway system before and after the implementation of Modules 1 and 2. Tables A2-11 provides a comparison of the average speeds on the freeway system before and after the implementation of Modules 1 and 2. Tables A2-12 and A2- 13 provide a summary of freeway screenline volume levels during collection of travel time data samples. It is noted that the average freeway screenline volume corresponding to before and after travel time runs increased by 1.38% to 7.15%.

Table A2-12: Average Freeway Screenline Traffic Volumes during Travel Time Studies on I-494 EB
Sum of Nicollet and Xerxes Screenline Volumes

6:00 to 9:00 AM Peak Period							7:30 to 8:30 AM Peak Hour						
Before ICTM			After Mod. 1 & 2			% change in volume	Before ICTM			After Mod. 1 & 2			% change in volume
Date	# of Runs	Volume	Date	# of Runs	Volume		Date	# of Runs	Volume	Date	# of Runs	Volume	
5/18/94	7	28,955	4/10/94	5	29,637		5/18/94	2	11,436	4/10/94	2	11,248	
5/26/94	3	27,553	4/11/94	5	29,461		5/26/94	2	10,436	4/11/94	2	11,344	
6/2/94	1	28,490	4/18/94	1	29,792		6/2/94	1	10,962	4/18/94	1	11,146	
Tot/Avg	11	28,520	Tot/Avg	11	29,568	3.51%	Tot/Avg	5	10,941	Tot/Avg	5	11,266	2.88%
3:00 to 6:00 PM Peak Period							4:30 to 5:30 PM Peak Hour						
Before ICTM			After Mod. 1 & 2			% change in volume	Before ICTM			After Mod. 1 & 2			% change in volume
Date	# of Runs	Volume	Date	# of Runs	Volume		Date	# of Runs	Volume	Date	# of Runs	Volume	
			4/10/94	3	37,050					4/10/94	1	13,214	
5/26/94	6	37,226	4/11/94	3	36,907		5/26/94	2	12,769	4/11/94	1	12,874	
5/31/94	6	36,492	5/7/94	4	37,549		5/31/94	2	12,672	5/7/94	2	13,403	
6/2/94	1	36,998	5/8/94	1	39,157		6/2/94	1	12,535	5/8/94	1	13,674	
Tot/Avg	13	36,870	Tot/Avg	11	37,384	1.38%	Tot/Avg	5	12,683	Tot/Avg	5	13,314	4.73%

Table A2-13: Average Freeway Screenline Traffic Volumes during Travel Time Studies on I-494 WB
Sum of Nicollet and Xerxes Screenline Volumes

6:00 to 9:00 AM Peak Period							7:30 to 8:30 AM Peak Hour						
Before ICTM			After Mod. 1 & 2			% change in volume	Before ICTM			After Mod. 1 & 2			% change in volume
Date	# of Runs	Volume	Date	# of Runs	Volume		Date	# of Runs	Volume	Date	# of Runs	Volume	
5/18/94	7	34,123	4/10/94	5	34,207		5/18/94	2	12,100	4/10/94	3	11,694	
5/26/94	3	31,105	4/11/94	5	34,324		5/26/94	2	9,496	4/11/94	2	11,739	
6/2/94	1	33,296					6/2/94	1	11,179				
Tot/Avg	11	33,225	Tot/Avg	10	34,266	3.04%	Tot/Avg	5	10,874	Tot/Avg	5	11,712	7.15%
3:00 to 6:00 PM Peak Period							4:30 to 5:30 PM Peak Hour						
Before ICTM			After Mod. 1 & 2			% change in volume	Before ICTM			After Mod. 1 & 2			% change in volume
Date	# of Runs	Volume	Date	# of Runs	Volume		Date	# of Runs	Volume	Date	# of Runs	Volume	
			4/10/94	2	34,225					4/10/94	1	11,651	
5/26/94	6	33,698	4/11/94	3	34,169		5/26/94	2	10,946	4/11/94	1	11,585	
5/31/94	6	32,850	5/7/94	3	32,394		5/31/94	2	11,386	5/7/94	2	11,349	
6/2/94	1	33,079	5/8/94	2	34,724		6/2/94	1	10,895	5/8/94	1	12,115	
Tot/Avg	13	33,259	Tot/Avg	10	33,759	1.48%	Tot/Avg	5	11,112	Tot/Avg	5	11,610	4.29%

- AM Peak Period (EB) - Freeway travel time on EB I-494 remained steady at 8.8 minutes during the 6:00 - 9:00 AM Peak Period and 9.3/9.4 minutes during the 7:30-8:30 AM Peak Hour before and after implementation of Modules 1 and 2. Average speeds on EB I-494 decreased slightly from 56.7 mph to 56.5 mph in the peak period and 54.0 mph to 52.7 in the peak hour. Eastbound freeway screenline volume data collected on the same days as the freeway travel time data show there was significantly more volume on the freeway after implementation of Modules 1 and 2. Eastbound freeway screenline volumes increased by 3.5 1% during the AM Peak Period and 2.88% during the AM Peak Hour. Statistical tests indicate there were no significant changes in travel time on EB I-494 during the AM Peak Period or AM Peak Hour. Of the two comparisons made to address the Evaluation Goals, both showed no support for the hypothesis. This conclusion was further supported by a statistical comparison which also indicated no statistical significance.

- AM Peak Period (WB) - Freeway travel time on WB I-494 decreased from 12.7 to 10.4 minutes during the 6:00 - 9:00 AM Peak Period and from 16.9 to 11.3 minutes during the 7:30-8:30 AM Peak Hour before and after implementation of Modules 1 and 2. Average speeds on WB I-494 increased from 45.4 mph to 50.4 mph (11 .O 1%) in the peak period and 35.0 to 49.8 (42.37%) in the peak hour. Westbound freeway screenline volume data collected on the same days as the freeway travel time data show there was significantly more volume on the freeway after implementation of Modules 1 and 2. Westbound freeway screenline volumes increased by 3.04% during the AM Peak Period and 7.15% during the AM Peak Hour. The 18.08% and 32.74% decreases in travel time on WB I-494 during the AM Peak Period and AM Peak Hour do meet the evaluation goal of a 10% decrease, however there are no statistically significant changes in average travel time on WB I-494 during the AM Peak Period and AM Peak Hour. Of the two comparisons made to address the Evaluation Goals, both showed support for the hypothesis. In comparison, a statistical analysis resulted in both comparisons having no statistical significance.

- PM Peak Period (EB) - Freeway travel time on EB I-494 remained relatively steady at 10.4 to 10.7 minutes during the 3:00 - 6:00 PM Peak Period and decreased from 11.7 to 10.7 minutes during the 4:30-5:30 PM Peak Hour before and after implementation of Modules 1 and 2. Average speeds on EB I-494 decrease slightly from 49.2 mph to 48.8 mph in the peak period, however average speeds increased from 44.4 mph to 48.8 mph during the peak hour. Eastbound freeway screenline volume data collected on the same days as the freeway travel time data show there was significantly more volume on the freeway after implementation of Modules 1 and 2. Eastbound freeway screenline volumes increased by 1.38% during the PM Peak Period and 4.73% during the PM Peak Hour. Statistical tests indicate there were no significant changes in travel time on EB I-494 during the PM Peak Period or PM Peak Hour. Of the two comparisons made to address the Evaluation Goals, both showed no support for the hypothesis. These conclusions were further supported by a statistical comparison which also indicated no statistical significance.

- PM Peak Period (WB) - Freeway travel time on WB I-494 decreased from 9.9 to 9.0 minutes during the 3:00 - 6:00 PM Peak Period and from 10.6 to 8.7 minutes during the 4:30-5:30 AM Peak Hour before and after implementation of Modules 1 and 2. Average speeds on EB I-494 increased from 51.8 mph to 55.5 mph in the peak period and 50.3 mph to 56.3 mph in the peak hour. Westbound freeway screenline volume data collected on the same days as the freeway travel time data show there was significantly more volume on the freeway after implementation of Modules 1 and 2. Westbound freeway screenline volumes increased by 1.48% during the PM Peak Period and 4.29% during the PM Peak Hour. The 17.56% decrease in travel time on WB I-494 during the PM Peak Hour do meet the evaluation goal of a 10% decrease, however there are no statistically significant changes in average travel time on WB I-494 during the PM Peak Period and PM Peak Hour. Of the two comparisons made to address the Evaluation Goals, one comparison supported the hypothesis and one showed no support for the hypothesis. A statistical analysis showed both comparisons having no statistical significance.
- Weekday Midday - Freeway travel time on EB I-494 remained relatively steady at 8.2 to 7.9 minutes during the 10:30 a.m. - 1:30 p.m. Weekday Midday Period before and after implementation of Modules 1 and 2. Average speeds on EB I-494 increased slightly from 58.4 mph to 60.8 mph. Freeway travel time on WB I-494 also remained steady at 8.0 to 7.8 minutes during the 10:30 a.m. - 1:30 p.m. Weekday Midday before and after implementation of Modules 1 and 2. Average speeds on WB I-494 increased slightly from 59.3 mph to 60.7 mph. The 3.74% and 2.02% decreases in travel time on EB and WB I-494 during the Weekday Midday Period do not meet the evaluation goal of a 10% decrease, however significant changes were not expected since Modules 1 and 2 did not implement strategies to address freeway operations during the Off Peak Period.
- Saturday Midday - Freeway travel time on EB I-494 remained steady at 7.9 to 8.1 minutes during the 10:30 a.m. - 1:30 p.m. Saturday Midday Period before and after implementation of Modules 1 and 2. Average speeds on EB I-494 decreased slightly from 60.2 mph to 58.9 mph. Freeway travel time on WB I-494 also remained steady at 8.1 to 7.9 minutes during the 10:30 a.m. - 1:30 p.m. Saturday Midday before and after implementation of Modules 1 and 2. Average speeds on WB I-494 increased slightly from 58.8 mph to 60.1 mph. The 2.77% increase and 1.65% decrease in travel time on EB and WB I-494 during the Saturday Midday Peak Period do not meet the evaluation goal of a 10% decrease, however significant changes were not expected since Modules 1 and 2 did not implement strategies to address freeway operations during the Off Peak Period.

Tables AZ-3 through A2-8 provide summaries of average travel time and delay on the arterial street system. See Hypothesis 1 - 1.2b for interpretation of average arterial travel time and delay summaries.

MOE l-l.3 - *Reduction in the number of arterial vehicle stops and delay within the corridor.*

- Hypothesis l-l .3a - *There is a decrease in the number of vehicle stops on the arterial street system.*

- Hypothesis 1-1.3b - *There is a decrease in stop time delay on the arterial street system.*

  Tables A2-3 through A2-8 provide summaries of average travel time, stop time delay, and number of stops on the arterial street system. See Hypothesis l-l .2b for interpretation of average arterial travel time, stop time delay, and number of stops summaries.

MOE l-l.4 - *Reduction in queue delays on freeway entrance ramps.*

- Hypothesis l-l .4a - *There is a decrease in the total vehicle delay per hour at freeway entrance ramp meters within the corridor.*

Table AZ-14: Average Ramp Delay Per Vehicle (minutes/vehicle)

Ramp Location		Average Delay Per Vehicle (minutes/vehicle)					
		AM Peak Hour (7:30-8:30 am)			PM Peak Hour (4:30-5:30 pm)		
ID	Description	Before	After	% change	Before	After	% change
4D4	France Avenue NB to EB I-494	0.11	0.02	-81.15%	5.53	6.24	12.89%
4E1	Penn Avenue to EB I-494	0.03	0.00	-100.00%	0.21	0.00	-100.00%
4E4	Lyndale Avenue to EB I-494	*0.00	*0.00	-	1.53	0.09	-94.09%
4E6	12th Avenue to EB I-494	*0.00	*0.00	-	**	0.00	-
4G2	24th Avenue to WB I-494	1.90	3.09	62.54%	10.94	0.43	-96.11%
4G7	Lyndale Avenue to WB I-494	6.19	4.82	-22.10%	3.99	0.31	-92.19%
4H2	Penn Avenue to WB I-494	7.86	2.65	-66.31%	1.38	3.15	127.88%
4H4	France Avenue SB to WB I-494	6.52	9.56	46.67%	11.19	4.68	-58.19%

* Ramp is not metered during this time period
**Missing entrance volume data

Tables A2-14 provides a comparison summary of the average vehicle delay experienced by motorists at eight sample entrance ramp meter locations. The average vehicle delay is calculated using observed queue lengths, meter operation, and entrance ramp volume data as illustrated in the sample delay calculation shown at the end of this test plan. The results above show mixed support for hypothesis 1-l .4a - *There is a decrease in the total vehicle delay per hour at freeway entrance ramp meters within the corridor.*

- AM Peak Hour (EB) - The sample locations of entrance ramp delays to EB I-494 during the 7:30-8:30 AM Peak Period indicate that both sample ramps experienced decreases in average vehicle delay. The average vehicle delay on the entrance ramps from SB France Avenue and Penn Avenue to EB I-494 decreased by 81.15% and 100%. These changes do meet the evaluation goal of 10% decrease. The entrance ramps from Lyndale Avenue and 12th Avenue to EB I-494 are not metered during the AM Peak Period. Of the two comparisons made to address the Evaluation Goals, both comparisons supported the hypothesis.

- AM Peak Hour (WB) - The sample locations of entrance ramp delays to WB I-494 during the 7:30-8:30 AM Peak Period indicate that 2 of 4 sample ramps experienced decreases in average delay per vehicle. The average vehicle delay on the entrance ramps from Lyndale Avenue and Penn Avenue to WB I-494 decreased by 22.10% and 66.3 1%. These changes meet the evaluation goal of 10% decrease. However, the other two ramps, 24th Avenue and France Avenue SB to WB I-494, experienced increases of 62.54% and 46.67% in average delay per vehicle. These increases contradict the evaluation goal of 10% decrease. Of the four comparisons made to address the Evaluation Goals, two comparisons supported the hypothesis.

- PM Peak Hour (EB) - The sample locations of entrance ramp delays to EB I-494 during the 4:30-5:30 PM Peak Period indicate that 2 of 3 sample ramps experienced decreases in average vehicle delay. The average vehicle delay on the entrance ramps from Penn Avenue and Lyndale Avenue to EB I-494 decreased by 100% and 94.09%. These changes meet the evaluation goal of 10% decrease. However, the entrance ramp from France Avenue NB to EB I-494 experienced an increase of 12.89% in average vehicle delay. The entrance volume data from 12th Avenue to EB I-494 was not available to compute average vehicle delays. Of the three comparisons made to address the Evaluation Goals, two comparisons supported the hypothesis.

- PM Peak Hour (WB) - The sample locations of entrance ramp delays to WB I-494 during the 4:30-5:30 PM Peak Period indicate that 3 of 4 sample ramps experienced decreases in average delay per vehicle. The average vehicle delay on the entrance ramps from 24th Avenue, Lyndale Avenue, and France Avenue SB to WB I-494 decreased by 96.11%, 92.19%, and 58.19% respectively. These changes meet the evaluation goal of 10% decrease. However, the ramp from Penn Avenue to WB I-494 experienced an increase of 127.88% in average delay per vehicle. Of the three comparisons made to address the Evaluation Goals, three comparisons supported the hypothesis.

- Hypothesis l-l .4b - *There are more consistent queue delays among adjacent en trance ramp meters.*

Table A2-15: Average Freeway Entrance Ramp Queue Delay by Metering Zone

Ramp Meter Zone Location	Average Delay Per Vehicle (minutes/vehicle)					
	AM Peak Hour (7:30 - 8:30 a.m.)			PM Peak Hour (4:30 - 5:30 p.m.)		
	Before	After	% change	Before	After	% change
Zone 4D - I-494 EB, EBLR to Penn Ave	NA	NA	-	NA	NA	-
Zone 4E - I-494 EB, Penn Ave to TH 77	NA	NA	-	0.45	0.03	-94.07%
Zone 4G - I-494 WB, 34th Ave to I-35W	4.03	3.99	-1.12%	7.64	0.36	-95.23%
Zone 4H- I-494 WB I-35W to EBLR	7.23	4.84	-33.04%	6.44	3.91	-39.28%

NA - Data not available from more than one ramp in zone

Tables A2- 14 provides a comparison summary of the average vehicle delay experienced by motorists at eight sample entrance ramp meter locations. Each sample ramp meter operates within a specified freeway zone or segment based on bottleneck locations on the mainline. Adjacent ramp meters are meters which operate within the same zone (i.e. zone 4D) as identified in the ramp meter ID. Table A2-15 provides a comparison summary of the average vehicle delay experienced at eight sample locations within the existing metering zones.

- <u>AM Peak Hour</u> - During the 7:30 - 8:30 AM Peak Hour, the average vehicle delay variation in zone 4G decreased dramatically from a variation of 4.29 to 1.73 minutes between the two adjacent sample ramp meter locations (Table A2-14). This decrease in variation justifies the increase of delay at (4G2) 24th Avenue to WB I-494 in order to balance the delays between the two adjacent ramps. The average delay per vehicle at the two adjacent ramps in zone 4G remained steady at 4.03 to 3.99 minutes (Table A2-15). In comparison, the average vehicle delay variation in zone 4H increased from a variation of 1.34 to 6.91 minutes between the two adjacent sample ramp meter locations. However, the average delay per vehicle at the two adjacent ramps in zone 4H decreased 7.23 to 4.84 minutes. There is no comparison available for zone 4D and 4E adjacent ramps. Of the two comparisons made to address the Evaluation Goals, one comparison supported the hypothesis.

- <u>PM Peak Hour</u> - During the 4:30 - 5:30 PM Peak Hour, the average vehicle delay variation in zone 4E decreased from a variation of 1.32 to 0.09 minutes between the two adjacent sample ramp meter locations (Table A2-14). The average delay per vehicle at the two adjacent ramps in zone 4E decreased from 0.45 to 0.03 minutes (Table A2-15). The average vehicle delay variation in zone 4G decreased dramatically from a variation of 6.95 to 0.12 minutes between the two adjacent sample ramp meter locations. The average delay per vehicle at the two adjacent ramps in zone 4G decreased 7.64

to 0.36 minutes. The average vehicle delay variation in zone 4H also decreased dramatically from a variation of 9.81 to 1.53 minutes between the two adjacent sample ramp meter locations. The average delay per vehicle at the two adjacent ramps in zone 4H decreased 6.44 to 3.91 minutes. There is no comparison available for zone 4D adjacent ramps. Of the three comparisons made to address the Evaluation Goals, all comparisons supported the hypothesis.

MOE 1-1.5 - *Reduction in queue delays at arterial intersections.*

- Hypothesis l-l .5a - *There is a decrease in the total vehicle delay per hour at arterial street/ramp terminal intersections during peak and mid-day travel periods.*

  There are no arterial intersection queue delay results at this point in the evaluation. Hypothesis 1- 1.5a results will be reported after the implementation of Module 3.

MOE 1-2.1 - *Reduction in the number of cycle failures at arterial and ramp terminal intersections.*

- Hypothesis 1-2.la - *There is a decrease in the number of cycle failures at arterial street and ramp terminal intersections.*

  There are no arterial intersection cycle failure results at this point in the evaluation. Hypothesis l-l .5a results will be reported after the implementation of Module 3.

6. Summary of Results

The travel time and ramp delay data evaluated in this test plan indicates that there is a general improvement in traffic operations within the corridor with the implementation of ICTM Modules 1 and 2, particularly on the freeway. Arterial street system components will be implemented in Module 3 and Module 4 and results will be reported in the proceeding reports.

- Average Travel Time/Speed - Average travel times on the freeway system show several notable improvements. The results from eight time period/directional comparisons indicate that three comparison results positively exceed the evaluation goal of 10% reduction in travel time. These positive results were found on WB I-494 during the AM Peak Period, AM Peak Hour, and PM Peak Hour. Average speeds on WB I-494 during these three time periods also increased by greater than 10%. The other five comparisons; I-494 WB during the PM Peak Period and I-494 EB during the AM Peak Period, AM Peak Hour, PM Peak Period, and PM Peak Hour, showed no basic change in average travel time or speed. It is noted there were no significant increases in travel time in any of the eight comparisons. Statistical tests indicate that there were no significant changes in travel time within a 95% confidence interval in any of the eight comparisons. Although not proven statistically, the improvements are considered relatively important since freeway screenline volumes increased by 1.38% to 7.15% after implementation of Modules 1 and 2 during the study periods.

- Travel Time Consistency - Consistency of travel time on the freeway system also showed improvements. The results from four time period/directional comparisons indicate that three comparison results meet the evaluation goal of more consistent travel time. These positive results were found on EB I-494 during the AM Peak Period, and WB I-494 during the AM Peak Period and PM Peak Period. The other comparisons, I-494 EB during the AM Peak Period showed a slight decrease in the consistency of travel time. Statistical tests indicate that the increased consistency of travel time on WB I-494 during the AM Peak Period is significant within a 95% confidence interval. The changes in consistency of travel time on WB I-494 during the PM Peak Period and EB I-494 during the AM and PM Peak Period are not statistically significant. Although not proven statistically, the improvements are considered relatively important since freeway screenline volumes increased by 1.38% to 7.15% after implementation of Modules 1 and 2 during the study periods.

- Average Ramp Meter Queue Delay - Average delay per vehicle at freeway entrance ramp meters show significant improvements. The results from 13 individual ramp/time period comparisons indicate that nine comparison results exceed the evaluation goal of a 10% decrease in vehicle delay. Four of the six ramps compared during the AM Peak Hour and five of seven compared during the PM Peak Hour show decreases in average delay per vehicle ranging from 22.10% to 100%. The other two ramps in the AM Peak Hour and two ramps in the PM Peak Hour show increases in the average delay per vehicle ranging from 12.89% to 127.88%. The increases in average vehicle delay at these four ramps can easily be justified when compared to the average delay per vehicle by zone and consistency of delay among adjacent ramp meter locations.

- Ramp Meter Queue Delay Consistency - The results from five zone/time period comparisons indicate that four comparison results meet the evaluation goal of more consistent delays among adjacent ramp meter locations. The more consistent delays were experienced within zone 4G during the AM Peak Hour and zone 4E, 4G, and 4H during the PM Peak Hour, The delays at adjacent ramp locations in zone 4H were less consistent during the AM Peak Hour. The average delay per vehicle within metering zones decreased for all zones during both the AM and PM Peak Hours.
  Therefore, the delays at adjacent ramps decreased overall and balanced out between adjacent ramps.

No arterial street system before/after comparisons of travel time, vehicle queue delays, or cycle failures were conducted as part of this test as the ICTM arterial intersection control components were not fully operational during the collection of operation condition traffic data. Evaluation of arterial street system operation will be conducted and reported as part of Module 3 and Module 4.

The overall result of this test plan is summarized below:

Freeway Travel Time/Speed	**Travel Time Consistency**
↓ Average Travel Time reduced by greater than 10% in 3 of 8 comparisons, no statistically significant changes overall.	↑ Consistency of Travel Time improved in 3 of 4 comparisons, one statistically significant change in the westbound direction during the 6:00-9:00 AM period.
Ramp Meter Queue Delays	**Freeway Screenline Volume**
↓ Average Delay per Vehicle reduced By greater than l0% in 9 of 13 individual comparisons and 4 of 4 by zone comparisons. ↓ Consistency in Delay among Adjacent Ramp Meter Locations improved in 4 of 5 comparisons.	↑ Screenline Volume levels were significantly higher during travel time data collection in all time periods after implementation of Modules 1 and 2.

Sample Calculation of Delay at Ramp Meters

Data Collected

Queue Length: The queue length is the number of vehicles in the ramp meter queue as counted in one-minute increments. Each on e minute of the hour long count will be used in the calculation of the total delay.

Ramp Metering Rate: The ramp metering rate is documented every 30 seconds by the ICTM regional computer. The rate for reach one minute of the hour long count will be obtained and used in the calculation of total delay. The metering rate is typically expressed in vehicles/hour. For the calculation, the number of seconds allowed for one vehicle to pass is required. This is equal to the inverse rate per hour times 3600 seconds per hour. (1 Hour/# Vehicles) * (3600 Seconds/l Hour).

To calculate the total delay in seconds for the our time period, a spreadsheet will be used. A sample spreadsheet calculation, and expansion of each column is include don the following pates.

SECONDS OF DELAY IN ONE HOUR AT METERED RAMP
sample spreadsheet
explanation of each column

column A	**column B**	**column C**	**column D**	**column E**	**column F**	**column G**	**column H**
minute	cars in queue	sec/veh	cars allowed through in 1 min	cars left in queue after 1min	# cars getting through in 1 minute	seconds of delay for cars that get through	add'1 delay for cars waiting >1 min
1	**7**	**5**	**12**	**0**	**7**	**140**	**0**

Column A: The minute which the data was collected.

Column B: The number of cars counted in the queue at the beginning of that minute,

Column C: The ramp metering rate as a seconds per vehicle rate.
Inverse of: (Vehicles/Hour) * (1 Hour/3600 seconds)

Column D: The number of vehicles which would be allowed to pass through the meter during the one minute period. (60 seconds/column C)

Column E: The number of actual vehicles which did not pass through the meter during the one minute period. (Column B - Column D) or zero if less than 1

Column F: The number of actual vehicles which did pass through the meter during the one minute period. (Column B - Column E)

Column G: The total number of seconds of delay that the cars in Column F waited during the one minute period. (C/2) * (Column F) * (Column F + 1)

Column H: The total number of seconds of delay which needs to be added to each vehicles that did not pass through the meter during the one minute period. (60 seconds * Column E).

The total delay for the hour will be the summation of Column G and Column H together.

$$\text{Delay per Vehicle} = \frac{\text{Total delay for the hour}}{\text{Hourly Ramp Volume}}$$

$$= \frac{18207 \text{ sec}}{150 \text{ veh}} = 121.4 \text{ sec/veh} = 2.0 \text{ min/veh}$$

SECONDS OF DELAY IN ONE HOUR AT METERED RAMP
sample spreadsheet

minute	cars in queue	sec/veh	cars allowed through in 1 min.	cars left in queue after 1 min.	# of cars getting through in 1 min.	seconds of delay for cars that get through	add'l delay for cars waiting >1 min.	
1	7	5	12	0	7	140	0	
2	8	5	12	0	8	180	0	
3	9	5	12	0	9	225	0	
4	5	5	12	0	5	75	0	
5	6	5	12	0	6	105	0	
6	7	5	12	0	7	140	0	
7	8	5	12	0	8	180	0	
8	10	5	12	0	10	275	0	
9	13	5	12	1	12	390	60	
10	15	5	12	3	12	390	180	
11	23	5	12	11	12	390	660	
12	20	5	12	8	12	390	480	
13	14	4	15	0	14	420	0	
14	13	4	15	0	13	364	0	
15	9	4	15	0	9	180	0	
16	8	4	15	0	8	144	0	
17	7	4	15	0	7	112	0	
18	10	4	15	0	10	220	0	
19	7	4	15	0	7	112	0	
20	8	4	15	0	8	144	0	
21	9	4	15	0	9	180	0	
22	5	4	15	0	5	60	0	
23	5	5	12	0	6	105	0	
24	7	5	12	0	7	140	0	
25	8	5	12	0	8	180	0	
26	10	5	12	0	10	275	0	
27	13	5	12	1	12	390	60	
28	15	5	12	3	12	390	180	
29	23	5	12	11	12	390	660	
30	20	5	12	8	12	390	480	
31	14	5	12	2	12	390	120	
32	13	5	12	1	12	390	60	
33	9	4	15	0	9	180	0	
34	8	4	15	0	8	144	0	
35	7	4	15	0	7	112	0	
36	10	4	15	0	10	220	0	
37	7	4	15	0	7	112	0	
38	8	4	15	0	8	144	0	
39	9	4	15	0	9	180	0	
40	5	4	15	0	5	60	0	
41	6	5	12	0	6	105	0	
42	7	5	12	0	7	140	0	
43	8	5	12	0	8	180	0	
44	10	5	12	0	10	275	0	
45	13	5	12	1	12	390	60	
46	15	4	15	0	15	480	0	
47	23	4	15	8	15	480	480	
48	20	4	15	5	15	480	300	
49	14	4	15	0	14	420	0	
50	13	4	15	0	13	364	0	
51	9	4	15	0	9	180	0	
52	8	4	15	0	8	180	0	
53	7	5	12	0	7	140	0	
54	10	5	12	0	10	275	0	
55	12	5	12	0	12	390	0	
56	13	5	12	1	12	390	60	
57	9	5	12	0	9	225	0	
58	7	5	12	0	7	140	0	
59	5	5	12	0	5	75	0	
60	4	5	12	0	4	50	0	
total						14367	3840	18207

Test Plan No. 3 - Ability of an Adaptive Control System to Implement Alternative Traffic Control Plans

1. Test Purpose

The purpose of this test plan is to determine the effectiveness of an adaptive control system to manage traffic during normal (recurrent congestion) conditions as well as during traffic fluctuations caused by incidents.

This test involves an analysis of ICTM system operators' perception of the adaptive control system timing plans during normal and incident traffic conditions. Specifically, operator perceptions of the effectiveness of the adaptive control system to implement timing plans in response to fluctuations in traffic flow will be evaluated. The test will also assess the promptness of the adaptive control system to implement timing plans to traffic flow conditions and will evaluate the coherence of transitions between different timing plans and integration of freeway/arterial street system operation.

2. Schedule of Test Activities

The execution of this evaluation test is set forth in the following activity schedule:

Activity	Date
Conduct Baseline Operator Interviews	Nov. '96 - Jan. '97
Conduct Post ICTM Operator Interviews	Nov. '97 - Jan. '98
Analysis and Reporting	Aug. - Dec. '98

3. Tabulated Data Collected, Analysis Methods, and Results and Interpretations

No activities in Test Plan #3 have been conducted at this point in the operational test. Operator interviews will be conducted after deployment. of Module 3 and Module 4. Results will be reported in the following Interim Report and the Final Report.

Test Plan No. 4 - Change in Corridor Safety Parameters

1. Test Purpose

The purpose of this test plan is to determine the effectiveness of the ICTM project to increase corridor safety by reducing arterial and freeway accidents in the I-494 Corridor. This test involves an analysis of corridor-wide accident data and consistency of freeway travel speeds. The corridor-wide accident data is used to determine the frequency of accidents on the freeway and arterial street systems, before and after ICTM. Freeway travel speed data to assess the variance of travel speed on the freeway system and its potential impact on freeway safety.

2. Schedule of Test Activities

The execution of this evaluation test is set forth in the following activity schedule:

Task	Date
Collection of Before ICTM Travel Speed Data	May 1994
Collection of After Module 1 and 2 Speed Data	April 1996
Comparison of Travel Speed Data	August 1996
Collection of 1994 Accident Data	August 1996
Collection of 1997 Accident Data	July 1998
Comparison of Accident Data	August 1998

3. Tabulated Data Collected

Before and after Module 1 and 2 freeway travel speed data and before ICTM accident data samples are available through the ICTM Project Manager and/or HNTB Corporation.

4. Analysis Methods

MOE 1-4.1 *Reduction in speed fluctuations along the freeway attributed to ICTM.*

Travel speed data collected during freeway travel time runs is used to determine the potential effectiveness of ICTM to improve safety within the I-494 corridor. The analysis includes a before/after comparison of average travel speed on I-494 and consistency of travel speed between adjacent freeway segments within the corridor during the AM, PM, and Midday peak periods and the Saturday Midday period. The statistical analysis includes the Levene's Test for Equality of Variances of travel speed.

MOE l-4.2 *Reduction in freeway/arterial accident frequencies and severity.*

There is no analysis associated with MOE l-4.2 as part of Moduies 1 and 2. The analysis of accident frequencies involves a one-year accident data comparison prior to deployment of Modules 1 and 2 and after implementation of Module 3. Before accident data is summarized in this report. The comparison of annual accident data will be evaluated in the final report.

5. Results and Interpretations

MOE 1-4.1 - Reduction in speed fluctuations along the freeway attributed to ICTM.

- Hypothesis 1-41. a - *There are fewer fluctuations in travel speed on the freeway system. attributed to ICTM.*

Table A4-1: Minimum/Maximum Travel Speeds on the Freeway System (mph)

	AM Peak Period (6:00 - 9:00 am)								AM Peak Hour (7:30 - 8:30 am)						
	Before			After			% change		Before			After			% change
	min	max	range	min	max	range	in range		min	max	range	min	max	range	in range
I-494 EB	17	68	51	23	68	45	-11.76%	I-494 EB	17	64	47	23	68	45	-4.26%
I-494 WB	10	66	56	17	68	51	-8.93%	I-494 WB	10	61	51	18	68	50	-1.96%
Total	10	68	58	17	68	51	-12.07%	Total	10	64	54	18	68	50	-7.41%
	PM Peak Period (3:00 - 6:00 pm)								PM Peak Hour (4:30 - 5:30 pm)						
	Before			After			% change		Before			After			% change
	min	max	range	min	max	range	in range		min	max	range	min	max	range	in range
I-494 EB	21	64	43	18	67	49	13.95%	I-494 EB	21	64	43	18	67	49	13.95%
I-494 WB	16	64	48	19	69	50	4.17%	I-494 WB	16	64	48	28	69	41	-14.58%
Total	16	64	48	18	69	51	6.25%	Total	16	64	48	18	69	51	6.25%
	Midday Period (10:30 am - 1:30 pm)								Saturday Midday (10:30 am - 1:30 pm)						
	Before			After			% change		Before			After			% change
	min	max	range	min	max	range	in range		min	max	range	min	max	range	in range
I-494 EB	33	67	34	46	71	25	-26.47%	I-494 EB	53	68	15	47	67	20	33.33%
I-494 WB	50	66	16	44	69	25	56.25%	I-494 WB	49	66	17	49	66	17	0.00%
Total	33	67	34	44	71	27	-20.59%	Total	49	68	19	47	67	20	5.26%

Figure A4-1

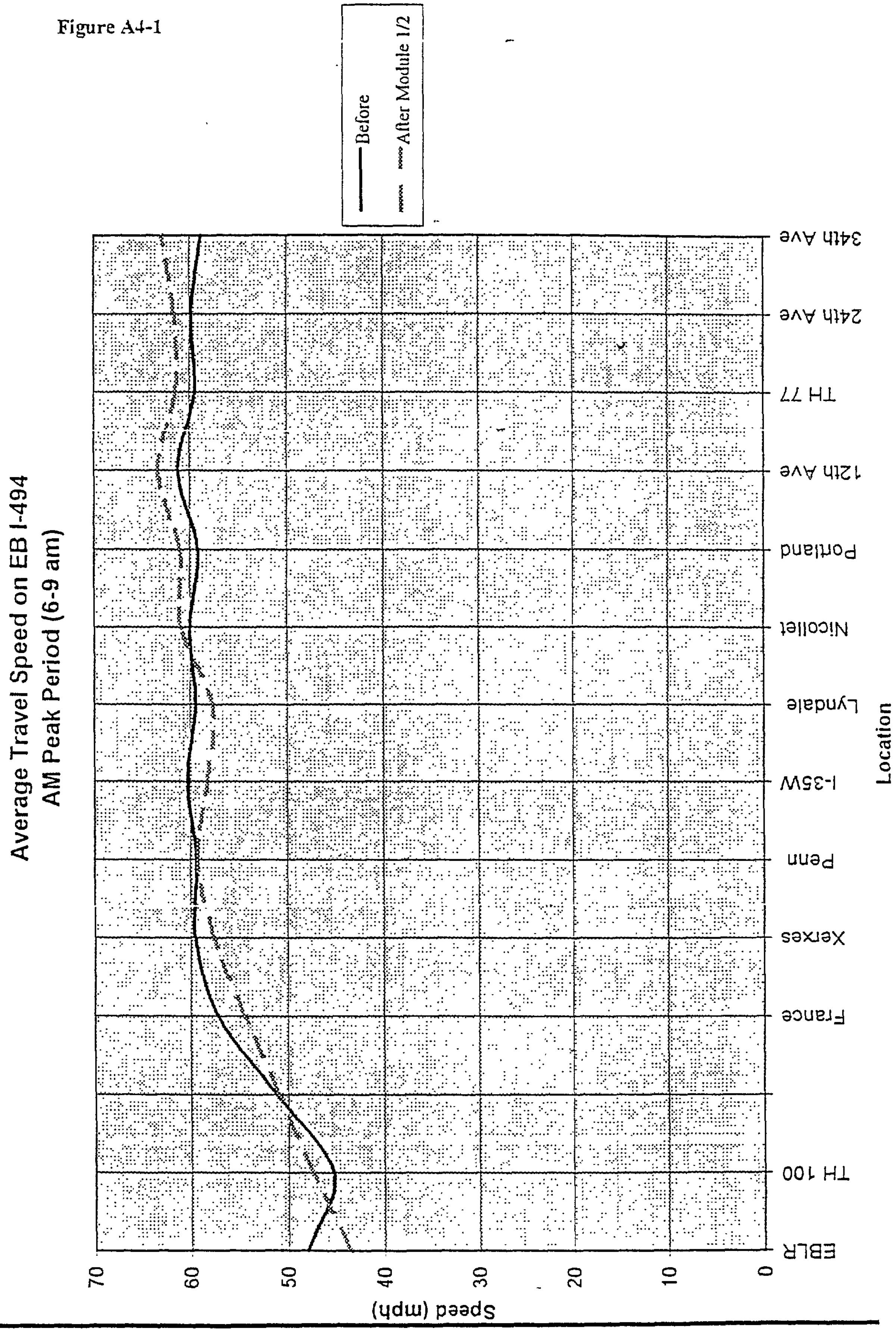

Average Travel Speed on EB I-494
AM Peak Period (6-9 am)
Before
After Module 1/2
Speed (mph)
70
60
50
40
30
20
10
0
Location
EBLR
TH 100
France
Xerxes
Penn
I-35W
Lyndale
Nicollet
Portland
12th Ave
TH 77
24th Ave
34th Ave

Figure A4-2

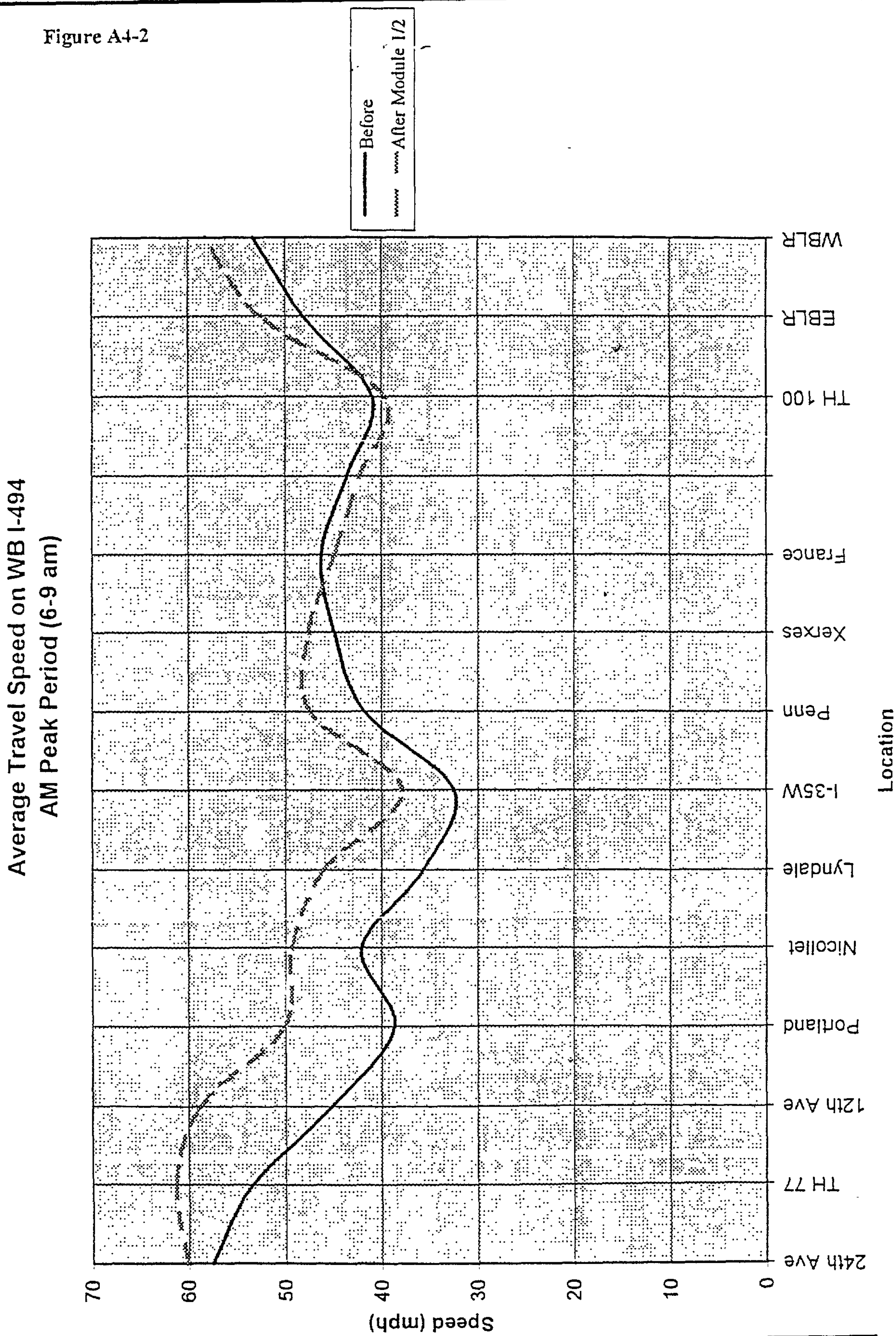

Average Travel Speed on WB I-494
AM Peak Period (6-9 am)
Before
After Module 1/2
Speed (mph)
70
60
50
40
30
20
10
0
Location
24th Ave
TH 77
12th Ave
Portland
Nicollet
Lyndale
I-35W
Penn
Xerxes
France
TH 100
EBLR
WBLR

Figure A4-3

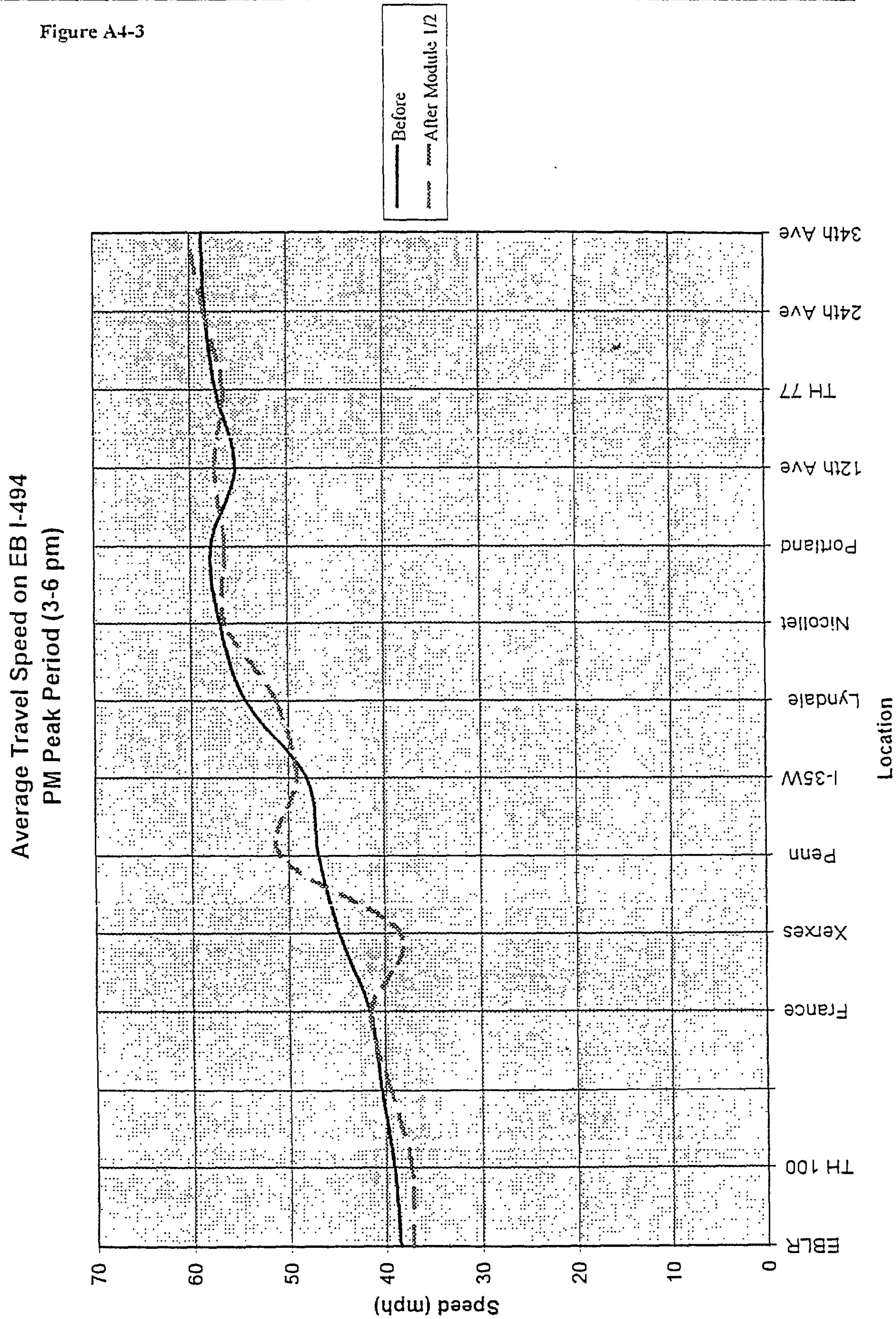

Average Travel Speed on EB I-494
PM Peak Period (3-6 pm)
Before
After Module 1/2
Speed (mph)
70
60
50
40
30
20
10
0
Location
EBLR
TH 100
France
Xerxes
Penn
I-35W
Lyndale
Nicollet
Portland
12th Ave
TH 77
24th Ave
34th Ave

Figure A4-4

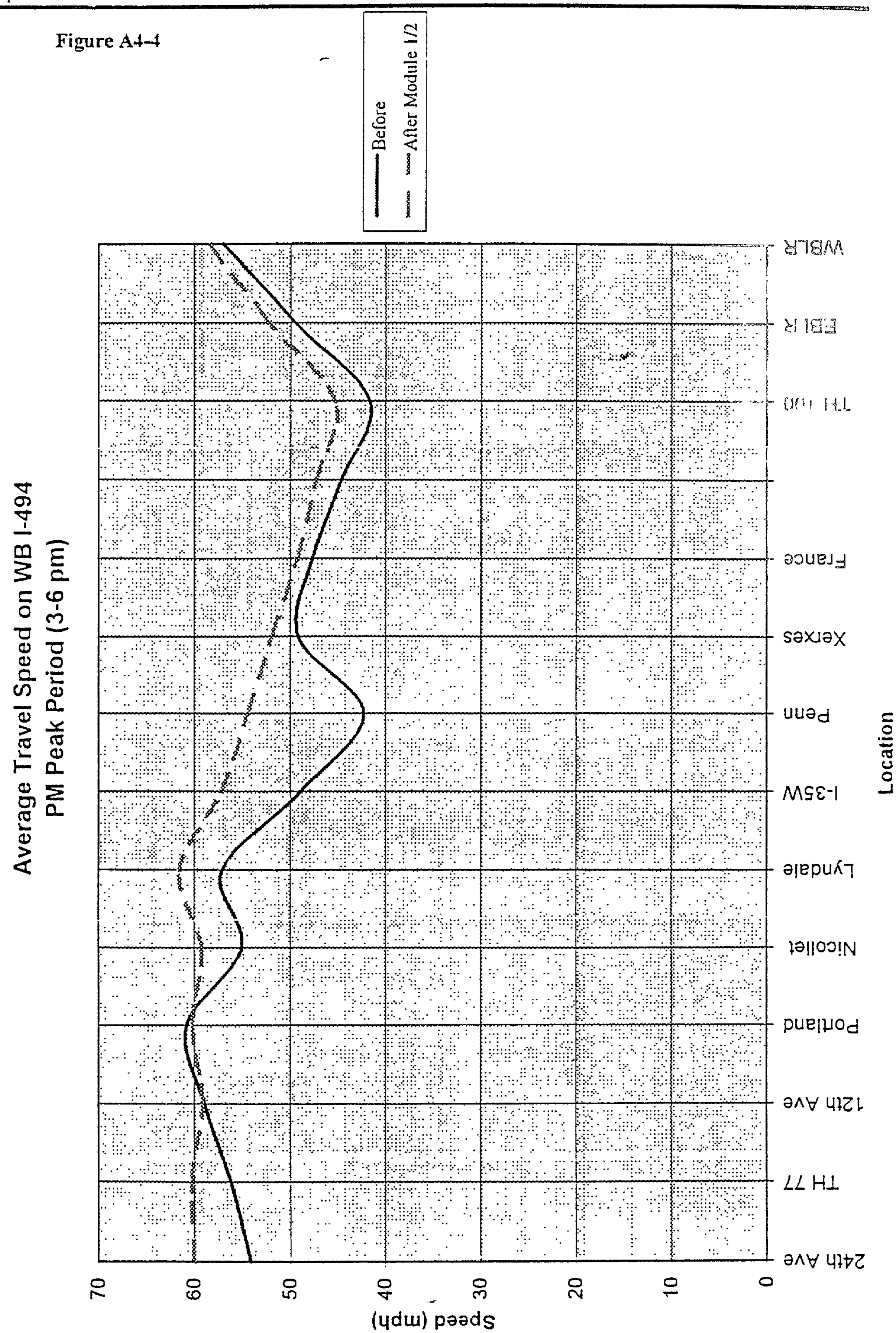

Average Travel Speed on WB I-494
PM Peak Period (3-6 pm)
Before
After Module 1/2
WBLR
EBLR
TH 100
France
Xerxes
Penn
I-35W
Lyndale
Nicollet
Portland
12th Ave
TH 77
24th Ave
Location
70
60
50
40
30
20
10
0
Speed (mph)

Table A4-2: Average Freeway Travel Speed (mph)

	AM Peak Period (6:00-9:00 am)			AM Peak Hour (7:30-8:30 pm)		
	Before	After	% change	Before	After	% change
I-494 EB	56.7	56.5	-0.35%	54.0	52.7	-2.41%
I-494 WB	45.4	50.4	11.01%	35.0	49.8	42.37%
Total	51.1	53.5	4.70%	44.5	51.3	15.19%
	PM Peak Period (3:00-6:00 pm)			PM Peak Hour (4:30-5:30 pm)		
	Before	After	% change	Before	After	% change
I-494 EB	49.2	48.8	-0.81%	44.4	48.8	9.91%
I-494 WB	51.8	55.5	7.14%	50.3	56.3	11.85%
Total	50.5	52.2	3.27%	47.4	52.5	10.94%
	Weekday Midday (10:30 am-1:30 pm)			Saturday Midday (10:30 am-1:30 pm)		
	Before	After	% change	Before	After	% change
I-494 EB	58.4	60.8	4.11%	60.2	58.9	-2.16%
I-494 WB	59.3	60.7	2.36%	58.8	60.1	2.21%
Total	58.9	60.8	3.23%	59.5	59.5	0.00%

Table A4-3: Levene's Test for Equality of Variances

	Number of Cases	Mean	Standard Deviation	SE of Mean	Mean Difference	F	P
All Periods Combined							
Before ICTM	116	53.7142	8.239	0.765			
After Module 1 and 2	98	55.7755	6.013	0.607	-2.0613	7.621	0.006

Table A4-1 provides a comparison of minimum and maximum speeds recorded during travel time runs on the freeway system. The results indicate there is significantly less variation in the travel speed on I-494 during the Aii Peak Period, AM Peak Hour, and Midday Period. PM Peak Period, PM Peak Hour, and Saturday Midday results indicate an increase in travel speed variation. According to Levene's Test for Equality of Variances in Table A4 .3 overall speeds are significantly more consistent after Module 1 and 2 implementation. Standard deviation in travel speeds decreased from 8.2 to 6.0 mph. It is noted, as shown in Table A4-2 that for all time periods analyzed, average travel speeds remained relatively constant or increased after implementation of Module 1 and 2. Of particular interest, average freeway speeds increased by 15.19% in the AM Peak Hour and 10. 94% in the PM Peak Hour.

Figures A4-1, 2, 3, and 4 show the average travel speed by segment on eastbound and westbound I-494 during the AM and PM Peak Periods. The figures show the overall increase in travel speed and specific areas where travel speed consistency improved after the implementation of Modules 1 and 2.

MOE l-4.2 - Reduction in freeway/arterial accident frequencies and severity.

Table A4-4: Number of Accidents in 1994 in the I-494 Corridor

	Arterial Street System			Freeway System			Corridor-wide		
	Property Damage Only	Injury/ Fatal	Total	Property Damage Only	Injury/ Fatal	Total	Property Damage Only	Injury/ Fatal	Total
AM Peak Period	58	27	85	103	26	129	161	53	214
Weekday Midday	149	62	211	121	42	163	270	104	374
PM Peak Period	119	67	186	113	40	153	232	107	339
Weekday Nighttime	103	39	142	98	33	131	201	72	273
Weekend	80	38	118	69	27	96	149	65	214
Annual Total	509	233	742	504	168	672	1013	401	1414
Proportions	0.69	0.31	1.00	0.75	0.25	1.00	0.72	0.28	1.00

- Hypothesis l-4.2a - *There is a decrease in the frequency of accidents within the study corridor, attributable to ICTM*

  The frequency of accidents before the implementation of ICTM principles are presented in Table A4-4. There were a total of 1414 accidents reported in the study corridor in 1994. Of those reported accidents, 672 or 47.5% of the total occurred on the freeway system. In addition, 214 accidents or 15.1% of the total occurred during the AM Peak Period and 339 accidents or 24.0% occurred during the PM Peak Period. There are no comparisons or results available as part of the Module 1 and 2 evaluation. Hypothesis l-4.2a will be addressed in the Final Report with a before/after comparison of before ICTM data to post Module 3 data.

- Hypothesis l-4.2b - *There is a greater proportion of property damage only accidents compared to personal injury/fatal accidents, within the ICTM test corridor.*

  The proportion of property damage only accidents compared to personal injury/fatal accidents before the implementation of ICTM principles are presented in Table A4-4. There were a total of 1414 accidents reported in the study corridor in 1994. Of those reported accidents, 40 1 or 23.4% involved personal injuries/fatalities. There are no comparisons or results available as part of the Module 1 and 2 evaluation. Hypothesis l-4.2b will be addressed in the Final Report with a before/after comparison of before ICTM data to post Module 3 data.

6. Summary of Results

Travel speed consistency results indicate there is significantly less variation in the travel speeds on the freeway system. More consistent freeway travel speeds reduce the probability of accidents on the freeway system. Standard deviations of travel speeds decreased from 8.2 to 6.0 mph while the average travel speed increased from 53.7 to 55.8 mph after the implementation of Modules 1 and 2. Although speed consistency is not directly related to a reduction in accident frequency, it does serve as a potential indicator of reduced traffic flow conflicts on I-494 which may contribute to a potential reduction in freeway accidents.

Baseline accident data indicates there 1414 accidents in the ICTM corridor in 1994, 52.5% occurring on the arterial street system. The data also indicates 28.4% of all accidents involved personal injury/fatality and 71.6% involved property damage only. Baseline (1994) accident data will compared to post-ICTM (1997) accident data to determine the ability of ICTM to improve corridor safety.

Corridor Accidents.	Freeway Speed. Consistency
- 1414 accidents within the corridor in 1994 · 52.5% on the arterial street system · 40 1 personal injury/fatal accidents in 1994 (28.4%) - 1013 property damage only accidents (71.6%)	· a 2.2 mph reduction in standard deviation of freeway speeds

Test Plan No: 5 - Project Cost and System Deployment

1. Test Purpose

The purpose of the Project Cost and System Deployment test is to determine the cost of the ICTM operational test, the cost of system expansion within the I-494 test corridor, and the expandability and transferabiIity of an ICTM system to other corridors.

This test plan involves the documentation of all costs associated with the ICTM operational test and estimates the costs associated with continued use and expansion after the test. The evaluation relies on documentation of all capital, equipment, installation, maintenance, and operating costs of the ICTM system components as we11 as all contributions from participants involved in the project. The costs associated with the operational test will be used to determine the test's cost effectiveness and to project costs of continued and expanded use. This report only documents those ICTM activities that have been implemented to date involving the adaptive control system on the arterial traffic signals and ramp meters. Total project cost documentation will be contained in the final project evaluation report for ICTM.

2. Schedule of Test Activities

The activities in this test plan will be conducted on a continuous basis throughout the operational test. Results will be summarized in the interim and final reports after deployment of each module.

3. Analysis Methods

The analysis related to this test plan involves utilizing the documented project costs and the qualitative and quantitative results from other test plans, to evaluate ICTM's cost effectiveness in making use of the available transportation infrastructure, managing corridor-wide traffic during normal and incident-influenced conditions, improving corridor safety, and enabling multiple transportation agencies to work together; from a local and corridor-wide perspective. The evaluation will document the percent contributions from Mn/DOT, Hennepin County, City of Bloomington, City of Edina, City of Richfield, and private sector participants. The final evaluation results will identify total costs associated with the operational test as well as unit costs by miles of freeway, miles of arterials, number of arterial intersections, and number of freeway ramp terminal interfaces.

4. Results and Interpretations

A total of eight measures of effectiveness (MOEs) are documented in this test plan. Of those eight MOEs, only the first two pertaining directly to the documentation of all fixed and on-going costs (MOE 5-l. 1) and documentation of public and private sector contributions (MOE 5-l .2) are reported on in this interim test plan. The remaining MOEs pertaining to cost and improvements for expansion, base conditions that warrant the ICTM concept. core infrastructure for an ICTM system, on-going costs, and critical issues and lessons learned will be reported on in subsequent reports due to the timing of data availability. Interviews with system operators and managers are scheduled for early 1997 to obtain incremental answers to some of these MOEs. Other portions of these MOEs cannot be addressed until all components of the operational test are deployed and evaluated.

MOEs-1.1 *Document all fixed and on-going costs.*

Categories/Definitions

Interim (Module 1 and 2) project costs have been categorized into two groups: fixed; and, on-going costs. The *fixed costs* are capital expenditures for system implementation and are further defined as:

1. Project Development - Items or activities necessary for the development of the entire ICTM operational test (Modules 1 through 4). Key examples in this category include: the Master Plan; the Operations and Maintenance PIan; the Implementation Plan; and, the Project Evaluation.

2. Adaptive Control System-Traffic Signals - Items or activities associated with designing and implementing the SCATS adaptive control system on existing arterial traffic signals. Key examples in this category include: System Design and Construction; the DEC Computer; SCATS Signal Controllers; and, SCATS Software.

3. Adaptive Control System-Ramp Meters - Items or activities associated with designing and implementing the SCATS adaptive control system on existing ramp meters. Key examples in this category include: System Design and Construction, SCATS Ramp Meter Software and the Ramp Metering System User Interface.

4. Alternative Detection Technology - Items associated with designing and implementing Autoscope detection technology. Autoscope was installed at critical project locations to provide for detector location flexibility and limited (stationary) surveillance video.

ICTM Module 1 and 2 *on-going costs* are defined as:

i. Operations - Items or activities associated with operating the ICTM-system to date. Key examples in this category include: Mn/DOT and Participating Agency Staffing; System Training; and, Public Relations Material.

2. Maintenance - Items or activities associated with maintaining ICTM field elements to date.

3. Other On-Going Costs - Recurring (monthly) costs associated with the project. These costs include: DEC Computer Service Agreement: SCATS Support; and, Project Communication Lines.

- **Interim Results - Total Costs**

Table A5-1 summarizes the ICTM interim (Module 1 and 2) project costs by category. A breakdown of the items included in each of the above cost categories is found in Table A5-6 located at the back of this appendix.

Table A5-1 ICTM Module 1 and 2
Interim Fixed and On-Going Costs

Category	Cost
Fixed Costs	
1. Project Development	$656,924
2. Adaptive Control System - Traffic Signals	**$873,408**
3. Adaptive Control System - Ramp Meters	$4 16,975
4. Alternative Detection Technology	**$332,786**
Fixed Cost Total	**$2,280,093**
On-Going Costs	
1. **Operations**	**$545,526**
2. Maintenance	**$46.868**
On-Going Cost Total	**$592,394**
3. Other On-Going Costs (per month)	$1,314

- **Interim Results - Unit Costs**

To begin to gain an understanding of the magnitude of costs necessary to expand or transfer the adaptive control component of the ICTM system to another corridor, an interim assessment of unit costs has been made. Unit costs are based on the total fixed costs identified to date and the physical characteristics of the existing I-494 ICTM system (i.e. freeway/arterial miles, number of arterial intersections, and freeway ramp terminals). Unit costs are approximate and should be used by for planning-level estimates only. A breakdown of the physical system characteristics used in calculating unit costs is found in Table A5-2 Sample calculations for unit costs are contained in Table A5-7 located at the back of this appendix. Table A5-3 summarizes the ICTM interim unit costs to date.

Table A5-2 ICTM Modules 1 and 2
Physical Characteristics

Number of Freeway Miles (I-494)	7.9 Miles
Number of Perpendicular Arterial Miles	**6.5 Miles**
Number of Parallel Arterial Miles	16.2 Miles
Number of Arterial Traffic Signals pending Adaptive Control	**47**
Number of Arterial-Freeway Ramp Terminal Traffic Signals currently under Adaptive Control	**20**
Number of Ramp Meters	**27**

Table A5-3 ICTM Modules 1 and 2
Unit Costs

Unit	Cost
per Freeway Mile	$300,000
per Arterial Mile	$ 100,000
per Freeway Ramp Terminal Intersection	$115,000
per Arterial Traffic Signal'	(not available)

'Cost based on adaptive control fixed costs only (no operations/maintenance)

'Adaptive control to be implemented on Arterial Traffic Signals in Module 3

Though potentially significant, on-going operations and maintenance costs have not been included in the Module 1 and 2 interim report unit costs since the system has not been operational long enough to gain an accurate assessment of these costs. However, depending on cost data avaiIability, on-going costs will be included in the unit costs of future interim reports as well as the final evaluation report.

MOE 5-1.2 *Document pubiic and private sector contributions.*

Public and private sector contributions include both hard and soft contributions and are in addition to the fixed cost capital expenditures described previously. For the public sector, hard contributions include cash, data collection, installation of equipment, capital improvements, and operations meetings. Public sector soft contributions include: participation in SCATS training; management meetings; and, evaluation, public relations, and operations committee activities.

For the private sector, hard contributions include equipment discounts, training, field work, and travel. Private sector soft contributions include meeting participation and equipment set-up/troubleshooting.

Module 1 and 2 public and private sector contributions are summarized in Tables A5-4 and **A5-5**

Table A5-4 Module 1 and 2 Public and Private Sector Hard Match Contributions

Agency / Partner	Hard Match Contribution (Module 1, 2)	Percent of Total
Public Sector		
Mn/DOT	$ 785,512	71.0
Hennepin County	$ 126,256	11.4
City of Bloomington	$ 34,955	3.2
City of Richfield	$ 12,593	1.1
City of Edina	$ 2.088	0.2
Subtotal	**$ 961,404**	**86.9%**
Private Sector		
AWATSA, Inc.	$ 59,420	5.4
Remix Corporation	$ 12,633	1.1
Traffic Control Corporation	$ 72.970	6.6
Subtotal	**$ 145,023**	13.1
TOTAL	**$ 1,106,427**	**100.0%**

Table A5-5 Module 1 and 2 Public and Private Sector Soft Match Contributions

Agency / Partner	Soft Match Contribution (Module 1, 2)	Percent of Total
Public Sector		
Mn/DOT	**$ 174,805**	**51.9**
Hennepin County	$ 38,879	11.5
City of Bloomington	**$ 23,609**	**7.0**
City of Richfield	**$ 10,751**	**3.2**
City of Edina	$ 3.971	1.2
Subtotal	$ $2,015	**74.8**
Private Sector		
AWATSA, Inc.	$ 80,653	**24.0**
Remix Corporation .	$0	5.4
Traffic Control Corporation	**$ 4.000**	**1.1**
Subtotal	**$ 84,653**	**25.2**
TOTAL	**$ 336,668**	100.0%

MOE 5-3.1 *Document the base conditions which warrant the ICTM concept for another corridor.*

MOE *5-3.2* *Document core infrastructure required to incorporate the ICTM system.*

MOE *5-3.3* *Document variable and on-gorng costs for deployment in another corridor,*

MOE *5-3.4* *Document critical issues and procedures needed for implementation of ICTM concept.*

MOE *5-3.5* *Document lessons learned in depioying the ICTM system.*

There are no interim results to report for MOEs 5-2.1 and 5-3.1 through 5-3.5. These MOEs deal primarily with issues relating to ICTM system expansion and transferability and will require additional information that will be gathered in Modules 3 and 4. Results will be available in the final evaluation report.

Table A5-6:

1. ICTM Module 1 and 2 Fixed and On-Going Costs

FIXEDCOSTS

1. PROJECT DEVELOPMENT (for entire project - 4 Modules)

Item	Cast	Notes
Master Plan	$85,744	
Operations and Maintenance Plan	$88,000	
Implementation Plan	$99,000	
Project Evaluation	$384,180	includes consultant support and participating local agency data collection for evaluation
SUB TOTAL	$656,924	

2. ADAPTIVE CONTROL SYSTEM - TRAFFIC SIGNALS

Item	cost	Notes
Module 1&2 Design	$99,418	PS&E for Module 182 Construction (see next entry)
Module 1&2 Construction	$298,309	includes interconnect/comm., system integration
DEC Computer	$35,064	
DEC SCATS Hardware	$22,476	supplemental hardware to operate SCATS on DEC
AWATSA Professional Services	$101,745	Project Management, Travel, Technical Support
SCATS Signal Controllers	$ 110,334	28-Delta 3 Controllers
SCATS Communication Interfaces	$25,063	
SCATS Software	$133,125	.
Peripheral Workstations	$36,992	8-486 MHz Windows PCs with modems
PC Tape Drive, 2-Dial-up Modems	$882	
LinkView/VS View Software Packages	$10,000	optional operations/data extraction software tools
SUB TOTAL	$873,408	

3. ADAPTIVE CONTROL SYSTEM - RAMP METERING SYSTEM (RMS)

Item	cost	Notes
Module 1&2 Queue Detector Design (RMS)	$6,250	
Module 1&2 Ramp Meter Syst Construction	$171,155	Includes queue loops, RMS 170 upgrades
AWATSA Professional Services	$107,490	Project Management, Travel, Technical Support
SCATS Ramp Metering Software Develop.	$72,000	
Mn/DOT TMC Software Development	$4,080	
Ramp Metering System User Interfaces	$54,000	
SUB TOTAL	$416,975	

4. ALTERNATIVE DETECTION TECHNOLOGY

Item	Cost	Notes
Autoscope Design	$6,500	
Autoscope Equipment - Penn Avenue	$161,113	
Autoscope Installation - Penn Avenue	$84,467	
Autoscope Installation - 24th/34th	$76,978	
Line Isolation Units	33,728	
SUB TOTAL	$332,786	

ON-GOING COSTS

1. OPERATIONS -TRAFFIC SIGNAL/RAMP METER ADAPTIVE CONTROL SYSTEM .

Item	cost	Notes
Mn/DOT Project Staffing		
ICTM Project Manager	$120,000	
Mn/DOT ICTM Project Support Staff	$148,014	
Mn/DOT Operations Staff	$97,964	
Mn/DOT Misc. Staff Operations Costs	$7,468	Includes vehicle useage and misc. supplies
Participating Local Agency Staffing		
Bloomington	$29,398	
Edina	$4,071	
Hennepin County	**$38,582**	
Richfield	**$14,852**	
System Training		
Adaptive Control	$32,720	
Ramp Metering	**$4,500**	
Computer Rental for Training	$2,490	
Video Monitors (3)	$996	
SCATS Dial-Up Line	$1,278	additional line needed for multi-agency operation
ESS Communications Test Line	$2,272	
Public Relations Material	$40.920	
SUE TOTAL	**$545,526**	

2. MAINTENANCE -TRAFFIC SIGNAL/RAMP METER ADAPTIVE CONTROL SYSTEM

Item	cost	Notes
Adaptive Control System		
Mn/DOT		
Labor-Signal Maintenance (ESS)	$20,129	includes labor and billing overhead of 36.5%
Labor-TE Requests (ESS)	$13,765	includes labor and billing overhead of 36.5%
Vehicle Charges (ESS)	$1,751	includes bucket truck, van charges, billing OH 36.5%
Local Agencies	$1,391	
Ramp Metering System		
Mn/DOT		
Labor-Ramp Meter Maintenance (ESS)	$8,534	includes labor and billing overhead of 36.5%
Vehicle Charges (ESS)	$1,298	includes bucket truck, van charges, billing OH 36.5%
SUBTOTAL	**$46,868**	

3. OTHER ONGOING COSTS

Item	cost	Notes
DEC Computer Service Agreement	$261	monthly cost
SCATS Support (maint., software)	$833	monthly cost based on $10,000 annual contract
Project Communication Lines	$22.0	monthly cost (16 separate telephone lines)
ON-GOING COSTS TOTAL	$1,314	monthly cost

Table A5-7 Module 1 and 2 Unit Cost Calculations

Unit Costs Basis

All unit costs are based on a total Module 1 and 2 fixed cost of $2,280,093 as specified in Table 1. Operations and maintenance costs are not included.

Cost Per Freeway Mile

$2,280,093 / 7.9 miles = $288,619 (say $300,000)

Cost Per Arterial Mile

$2,280,093 / 22.7 miles - $100,445 (say $100,000)

Cost Per Freeway Ramp Terminal Intersection

$2,280,093 / 20 ramp intersections = $114,005 (say $115,000)

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Test Plan No. 6 - Value to Agencies

1. Test Purpose

The purpose of this test plan is to determine the value of ICTM to participating transportation agencies. The evaluation assesses the agency perceptions of the effectiveness of ICTM to manage corridor traffic, meet the needs of participating agencies, operate corridor traffic control via adaptive control, and assess the effects of ICTM on the transportation systems. The evaluation relies on operator comments/observations obtained through interviews and discussion groups with key agency personnel.

2. Schedule of Test Activities

The execution of this evaluation test is set forth in the following activity schedule:

Activity	Date
Conduct Baseline Agency Interviews/Discussion Groups	Nov. '96 - Jan. '97
Conduct Post ICTM Operator Interviews/Discussion Groups	Nov. '97 - Jan. '98
Analysis and Reporting	Aug. - Dec. '98

3. Tabulated Data Collected, Analysis Methods, and Results and Interpretations

No activities in Test Plan #6 have been conducted at this point in the operational test. Interviews and discussion group meetings with key agency personnel will be conducted after deployment of Module 3 and Module 4. Results will be reported in the following Interim Report and the Final Report.

Test Plan No.7 - Impact on Corridor Motorists, Residents, and Businesses

1. Test Purpose

The Purpose of the Test Plan for Impact on Corridor Motorists. Residents. and Businesses is to evaluate and document the effect, and response of the ICTM system on the above population groups across the corridor. It is believed that motorists and business will see a perceptible positive change in the corridor due to achievement of the program goals of reducing travel on freeways for short trips and improving traffic control throughout the arterial and freeway access systems. The implementation of corridor wide control and strategies for traffic management will proceed over the course of four years allowing for a measure of change in public perceptions and travel pattern changes over time gauged against the modules implemented.

2. Schedule of Test Activities

The execution of this test is set forth in the following activity schedule:

Task	Assessment Date
1. User Feedback Log Review and Documentation	Continuous
2. Telephone Survey	April/May 1996
3. Focus Groups	April 1996

3. Tabulated Data Collected

Baseline public perception data collected through focus groups and telephone surveys is available through the ICTM Project Manager and/or HNTB Corporation.

4. Description of Analysis methods

a. Data Reduction

Focus group transcripts will be reviewed and highlighted for key findings for each discussion guide topic that is probed. Definitions and key terms useful in describing study group attitudes and perceptions will be noted for use in later construction of quantitative survey instruments. All attribute and ranking responses will be compiled for later comparison and analysis with data from other test instruments.

Tabulation of quantitative data gathered in Assessment surveys will be processed on a UNIX computer at MarketLine Research. Tabulation will provide a frequency count of a response with calculated means where appropriate. Tabulation also will help to identify outliers (observations very different in value from the rest). These are quirks in the data that might change an analysis and ultimately the interpretation of results.

Tabulated output will take the form of either one-way (simple) tabulation tables or cross-tabulation tables. One-way tabulation tables show frequency counts and percentages for single variables. Each variable is independent from other tabulated variables. Degree of item non-response is indicated, and input for summary statistics is provided. Where numerically appropriate, the means of all responses for a question will be noted at the bottom of the table. The base number, the number of respondents used in calculating this mean, appears below it. One-way tabulation tables are useful for examining the variables of the study separately and providing easy to comprehend summaries of collected data.

Various computer generated cross-tabulation tables will show the relationship of two or more study variables treated simultaneously. Cross tabulation is a more effective mechanism for studying the relationships among and between study variables. The number of cases that have the joint characteristics are shown by frequency count and percentages.

Using cross tabulation, the sample responses will be divided into subgroups in order to learn how various dependent variables such as perceived value, ICTM awareness, usefulness of variable message signs, etc. might vary from subgroup to subgroup.

Report banners are defined based on a review of processed survey data and MOE requirements. A banner is a series of cross-tabulations between a criterion or dependent variable and several (sometimes many) explanatory variables in a single table.

b. Data Analysis

Qualitative data collected by means of focus group discussions will be reviewed for trends and flags. The review will be for descriptive purposes of summarizing focus group findings.

Quantitative data collected in assessment surveys will be analyzed using appropriate statistical tools to accept or reject test hypotheses where applicable. Summary statistics will also be used to report findings and draw test conclusions, The scale of measurement in which ICTM test data was collected will dictate the way in which it is analyzed. Data is of an ordinal, nominal or interval nature. Nominal data is used to classify individuals or groups, in this test this will include such information as respondent sex, age, place of residence within the corridor etc. Ordinal data reflects the relative amount of some variable. Examples in the test include responses dealing with ranking of items such as traffic information sources or rating of a characteristic such as the value of the variable message signs (VMS). Interval data has all the characteristics of nominal and ordinal data with the additional feature that the interval between points are equal. An example might be the average daily number of miles driven within the corridor by various user groups.

Hypotheses associated with ICTM MOEs will require either tests of association or differences. Analysis will examine the 'sameness' variables share with one another or the 'differences' among them, for example, user groups as related to a variable. This might be 'sameness' or 'differences' of corridor residents/motorists and business owners/employees in awareness levels of ICTM technology components.

The analysis of association and differences may employ standard parametric statistical tests such as: contingency table analysis, the Phi coefficient, Spearman Rank Coefficient, Pearson Product Moment or t-Test.

Associations first will be analyzed using cross-tabulation tables. This level of analysis is efficient in that it only requires calculated percentages to examine relationships. Crossbreaks will be used to examine relationships between two test variables or user groups. This analysis will provide insight into the nature of a relationship for example between awareness of the ICTM program and the perceived value of VMS. Interpretation involves examination of cell frequencies and marginal frequencies. Interpretation of crossbreaks gets more complicated as the number of categories for each variable increases and when an additional variable is added to the analysis to refine the interpretation. The addition of one or more variables to a two-way cross-classification analysis is equivalent to holding each of the variables constant.

The Phi Coefficient is appropriate for examination of relationships in 2x2 cross-tabulations. Spearman Rank Correlation will be used when ordinal variables such as a rating scale is present in the analysis. Pearson Product Moment is appropriate indicator of association between two variables when data possesses properties of interval measurement. For example, this test would be used to measure the degree association between satisfaction with ICTM and resident's age.

Hypotheses relating to group differences and attitude and/or perception differences will be tested using contingency table analysis and the t-Test for differences in means. Contingency table analysis will be used for situations involving independent nominal data. The t-Test will be used in situations where gathered data is in the form of interval or ratio data. The assumption underlying the correct use of the t-Test is that samples are independently drawn from normal populations with equal population variances. The t-Test is efficient even when the above assumptions are violated.

Questionnaires will be designed to allow for collecting mean values and evaluating differences of proportions among various study subgroups. A z-test will be used to evaluate differences in proportions. Where possible the most straight forward and simple tool will be employed that can deliver the needed reliability and precision.

Analysis will be computed using MarketLine's UNIX computer capabilities and desktop computer such as Microsoft Excel. Additional off-the-shelf tools will be used if the desired analysis warrants.

5. Results and Interpretations

MOE 4-1.1 *Motorist's perception of ICTM information*

- Hypothesis 4-1.1a *Motorists can make informed route decisions based on ICTM information provided to them.*

  Findings reported below are drawn from tabulated data sets 26, 27, 40 & 41 appearing in the data sample available through the ICTM Project Manager and/or HNTB Corporation.

  Four out of five (80%) drivers on I-494 find current traffic information displayed on electronic signs helpful. Almost half of the drivers (42%) find existing information very helpful. Qualitative results from the focus groups session supported this data with several respondents requesting an increase in the number of CMS to provide information. These user perception measures provide a good baseline against which user value perceptions of VMS real time traffic and route information can be compared at the end of testing after ICTM Module 4 has been deployed.

  For the one out of five drivers finding the current system lacking, the primary reasons stated center on timeliness for 56% of these drivers and accuracy for 37%. Focus group participants suggested that when they drive up to a CMS (Changeable Message Sign) displaying a message it is too late to avoid the incident generated traffic delay or that the incident will have already cleared. These benchmark values will provide for meaningful comparisons after driver exposure to the VMS (Variable Message Sign).

  Currently the majority of surveyed drivers (74%) state they do not typically use traffic information to plan daily trips. Qualitative results from the focus groups session supported this data with most respondents stating a preference for using personal experience rather than traffic information sources.

  For the one in four drivers using traffic information to plan daily trips, the reported source usage is: traffic radio (80%), slow ramp meters or long ramp lines (48%), electronic message signs (47%) and television newscasts (44%). Qualitative results from the focus groups session indicated that respondents also rely on local newspapers as a source of traffic information. Sources reported as used most often are broadcast media, traffic radio (58%) and television newscasts (23%). Existing freeway message signs are reported to be used most often as a source of trip planning by only 4% of surveyed drivers. This would not indicate a strong currently perceived value associated with electronic message signs as a source of real time traffic information.

These benchmarks will be used for comparison and reliance measures between current traffic information sources and ICTM sources at the completion of the test.

MOE 4-1.2 *Change in travel patterns attributed to traffic information.*

- Hypothesis 4-1.2a *Motorists will divert or change travel patterns due to corridor information.*

Since the VMS is not operational at this time, no user perceptions of information accuracy specific to VMS was gathered. Baseline accuracy perceptions of existing electronic message signs were gathered as reported in results related to MOE 4- 1.1.

Focus group participants were queried as to if they would change their travel patterns after hearing a description of the ICTM project. Participants indicated that if ICTM was effective it should increase their ability to be flexible in traversing the corridor, especially for short trips.

MOE 4-2.1 *Change in motorist's attitude in route selection.*

- Hypothesis 4-2.1a *Motorists will express confidence in utilizing local routes instead of freeways.*

Findings reported below are drawn from tabulated data sets 28, 29, 30, 37, 38 & 39 appearing **in** the data sample available through the ICTM Project Manager and/or HNTB Corporation.

Baseline data is reported here and will form the basis for comparisons at the end of the test to determine whether motorists are making route changes based on perceived improvements in traffic through the corridor and confidence in arterial street as viable alternatives for short trips.

Three quarters of surveyed drivers indicate occasional use of arterial streets in the past twelve month period. Half of these occasional arterial street users report frequent use versus 15% stating they seldom use arterial street.

Stated decision factors on whether to take I-494 or an arterial focus on
I-494 related factors for 75% of drivers surveyed, Primary decision factors relate to perceived I-494 congestion (32%), I-494 rush hour traffic (22%), and long ramp meter lines (13%). Qualitative results from the focus groups session were supportive of these perceptions. Participants were quick to note the improved 76th/77th streets as being an alternative to I-494 and it's perceived negative factors. These are all features viewed as disadvantages in selecting I-494.

Despite widely perceived disadvantages in I-494 use that are reported to influence the decision process when faced with the option of using I-494 versus arterial alternatives, current use of freeway versus arterial street for short trips is about evenly split in terms of likelihood and frequency of use. Focus group qualitative data stressed the participants usage of side streets for short trips rather than taking I-494. However, several reported still using I-494 even with the new alternatives.

46% of surveyed drivers indicate they are very likely to extremely likely to use the freeway for short trips. Significant opportunity exists for ICTM to influence a measurable shift in this pattern over time.

The fact that significant numbers of surveyed drivers are *extremely likely* (23%) or *very likely* (24%) to use the freeway for short trips coupled with the fact that 70% indicate this usage pattern has not changed over the past year provides a clear baseline against which the potential for ICTM to alter traditional driving patterns from short trip freeway driving to arterial street usage can be measured.

For the 30% of surveyed drivers that indicate changes have occurred in their current freeway short trip usage patterns, reported factors influencing these changes will provide a reliable benchmark for both decision factor and frequency comparisons when end of test data is gathered.

For the 7% reporting increased usage of I-494 for short trips compared to a year ago, 71% of these drivers state reasons for pattern change that focus on ease of I-494 use. Focus group respondents cited that I-494 was an alternative to the Cross-town Highway, that it is busy, but they still use it because it is a straight shot thorough fare. In the case of the 22% indicating decreased usage (a shift from freeway to arterial), 45% of these drivers note traffic on I-494 as a cause for their pattern change.

MOE 4-2.2 *Motorists perceived improvements in corridor traffic operations attributed to ICTM*

- Hypothesis 4-2.2a *The motoring public cnn perceive improvements in freeway traf$c operations as a result of ICTM*

  Findings reported below are drawn from tabulated data sets 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19, 20, 21, 22, 23, 24, 31, 32, 33 & 37 appearing in the data sample available through the ICTM Project LManager and/or HNTB Corporation.

- Hypothesis 4-2.2b *The motoring public can perceive improvements in arterial traffic operations as a result of ICTM*

Findings reported below are drawn from tabulated data sets 22, 8, 15, 19, 23 & 24 appearing in the data sample available through the ICTM Project Manager and/or HNTB Corporation.

Current results relating to the above hypotheses provide baseline data against which end of test comparisons can be made to assess corridor efficiency increases potentially due to ICTM implementation.

About half of all drivers surveyed (47%) drive on I-494 at least three times per week. The perceived average time spent commuting on I-494 is currently about 15 minutes. Trip time is perceived to have remained constant over the past year for 60% of I-494 drivers, whereas it is perceived to have increased an average of roughly 8 minutes for a third (33%) of I-494 drivers.

Focus group participants reported driving on I-494 nearly everyday, yet most quickly pointed out alternative routes that they take (including 76th/77th Streets) when I-494 is congested ahead of them. Participants noted changes in the corridor, most notably the improved 76th/77th streets and the need for a “south side” improvement citing an inability to cross the corridor without zigzagging across 80th Street and others.

The consistency of these indicated trip times is perceived to be generally consistent. The average rating was 7.23 (10 = very consistent, 1 = not at all). When compared with other major freeways crossing the corridor, the I-494 average consistency rating is not significantly different. Currently perceived travel time consistency along I-494 is viewed as less consistent than along the arterial streets within the corridor. (See table 1. below).

Table 1: Travel Time Consistency

Route	Average Consistency Rating
I-494	7.23
35W	6.92
Highway 100	7.26
Cedar	6.83
N/S arterial	5.26
E/W arterial	7.89

(10 = very consistent, 1 = not at all)

For the 78% of I-494 users that gain access to I-494 at a metered ramp, their average perceived wait time at the meter is just over 4 minutes. Currently the average tolerance rating for this wait is 4.28 (1 = really don't mind, 10 = intolerable).

Overall the average tolerance rating for congestion on I-494 is close to mid range at 5.12. Current baseline perceptions related to trip quality along the I-494 corridor are not at either totally positive or negative extremes, but more in the mid to moderate range. This may reflect a resigned acceptance of conditions or a benchmarking of I-494 conditions against genera1 corridor wide and metro wide traffic conditions. For example, significant numbers of drivers express varying perceptions of commute time increases on various routes throughout the corridor (See table 2. Below). It is not evident whether the greater perceived time increase in I-494 commute time is a function of longer ramp wait times or higher congestion levels or a combination of both.

Table 2: Travel Time Changes

Route	% Users	Average Increase
I-494	33%	7.82 min
35W	42%	6.50 min
Highway 100	25%	5.71 min
Cedar	50%	3.67 min
N/S arterial	26%	4.14 min
E/W arterial	11%	2.00 min

Motorist perceived improvements in corridor arterial traffic conditions will be compared against baselines recorded for perceived current traffic signal coordination for uninterrupted trips and frequency of exposure to waits at stop signals when no opposing traffic is approaching.

60% of corridor residents feel they stop at signals on their most frequented arterial when there is no traffic in the opposing direction. Focus group qualitative data supported this with several individual intersections cited as having poorly timed lights. Frustration was expressed at sitting at long lights waiting while no cars were approaching from the cross streets. Better signal coordination through adaptive control should have **a** positive impact. Current values will be compared with stated perceptions at the end of test.

30% of corridor drivers feel green lights are seldom (22%) or never (8%) coordinated to allow them an uninterrupted trip. Despite the fact that 63% perceive the lights to be coordinated *occasionaly (34.4%)* and *frequently (3.6%)* and a third indicate they seldom or never have to stop at signals when there is no traffic in the opposing direction, their stated use of the freeway for short trips is not significantly different from non-residents. The majority of whom are most likely less familiar with the alternatives. 43% of residents compared to 52% of non-residents indicate they are *very likely* or *extremely likely* to use I-494 for short trips.

Baseline perceived traffic conditions expressed for arterial streets indicated as most frequented are not significantly different from expressed perceptions of I-494 conditiong by all surveyed motorists. (See table 3. Below).

Table 3: Perception Comparisons (mean ratings)

Measure	I-494	Arterial
Travel time consistency	7.23	6.43
Tolerance for congestion	5.12	4.47

Consistency: (10 = very consistent, 1 = not at all)
Tolerance: (10 = intolerable, 1 = really don't mind)

MOE 4-3.1 *Motorists perceived awareness of the project.*

- Hypothesis 4-3.1a *Motorists became aware of and supported the ICTM project.*

No survey results at this time. Public relations campaign was not underway at time of data collection. Surveyed drivers were not asked of ICTM awareness. No baseline data was required to effectively measure this hypothesis.

Focus group participants were all aware of the physical capital improvements to 76th/77th streets. During the focus group sessions a description of the ICTM project was related to the participants who expressed a willingness to support the project citing that persons will be less likely to jump onto the freeway for short trips. Business participants noted how increased traffic on the side streets would improve their business. Participants liked the idea of using technology to plan ahead, yet most noted that wider freeways may be a more permanent solution.

Focus group participants were asked to describe the best way to get information on the various ICTM projects out to them and their employees:

- Local newspaper - (Including the Sun Current)
- Media Blitz - have a big PR Campaign
- Publications - they send out newsletters to all employees, and requested a press release that they could distribute in the newsletter or insert with pay checks.
- Hold a launch meeting where Mn/DOT would invite a representative of each company. There the companies can pick up materials for distribution and Mn/DOT could formally announce the changes.
- Employ visual aids in describing the project for publications. Distribute a map with bright red roads showing which routes will get people east to west the quickest.

MOE 4-3.2 *Motorists perceived support for the project based on the information presented.*

- Hypothesis 4-3.2a *Motorists support of the project is based on the perceived benefits, their travel experiences, and the PR information materiais utilized*

No survey results at this time. Public relations campaign was not underway at time of data collection. Focus group data was the same as for MOE 4-3.1. Surveyed drivers were not asked of ICTM awareness. No baseline data was required to effectively measure this hypothesis.

MOE 6-3.1 *Corridor residents and businesses perceived changes in traffic conditions. (Safety, volume, operating conditions).*

- Hypothesis 6-3.1a *Local residents and corridor businesses will perceive a positive impact from changing traffic conditions.*

Findings reported below are drawn from tabulated data sets 16, 19, 33, 34, 35 & 36 appearing in the data sample available through the ICTM Project Manager and/or HNTB Corporation.

Current traffic condition perceptions of corridor arterial street users is generally positive. Conditions as relates to tolerance for congestion and perceived travel time consistency along motorist's most frequented arterial street vary little in comparison to perceived I-494 conditions as noted in Table 3.

Indicated baseline arterial street traffic condition is summarized on Table 4:

Table 4. Perceived Arterial Street Traffic Conditions

Condition	Rating
Travel time consistency	6.43
Tolerance for congestion	4.47
N/S travel time increase (26% users)	4.14 min
E/W travel time increase (11% of users)	2.00 min

(10 = very consistent, 1 = not at all)
(10 = intolerable, 1 = really don't mind)

The above baseline values will be compared with end of test values to identify any shifts in perceptions relating to arterial traffic conditions.

Current baseline data indicates most arterial drivers are not concerned with safety issues along arterial streets near I-494. Almost two-thirds of users surveyed (64.8%) expressed no concerns, 30% (57 motorists) indicated poor driving habits (15%), deficient street signs and markings (14%) and (8%) excessive speed as current arterial street safety concerns. Focus group qualitative data detailed some concerns for side streets because the speed limit is 35 and people go 50. Participants noted that the streets seemed a little dangerous, and that they worry about the driveways and kids, crossing the street, schools, churches and the elderly. The majority of surveyed arterial users (66.8%) indicate accessibility to their homes and businesses has not changed. This measure was taken after ICTM modules 1 and 2 going on-line. For those perceiving a change in accessibility, perceptions run two to one in terms of perceived decline versus perceived improvement in conditions (see Table 5 below).

Table 5. Perceived Ability to Leave Home or Business

Current status	% of Users
Improved	11%
Gotten worse	21.9%
Staved the same	66.8%

If as planned, increased awareness of the ICTM project, changes in travel patterns based on better traffic information, and shifts in motorist's attitudes in route selection result in greater use of nearby I-494 arterial streets for short trip driving. The above baseline values will provide solid benchmarks against which hypothesized positive ICTM impact can be assessed,

MOE 6-3.2 Corridor residents and businesses perceived value of ICTM project improvements

- Hypothesis 6-3.2a *Residents and local businesses will perceive a positive impact from the ICTM project.*

  Focus group business participants were asked to relate how ICTM improvements might affect their business with the following verbatim replies:

  - If more people take 76th/77th Street it would obviously help business.
  - One of the big problems with business is that if people get on the freeway, they are on it and less likely to jump off. If more people take the side streets, especially local residents whom we want to come to our store, or if there is a local route which is easier to take for short trips, it wouid make a huge difference.

Residents and businesses will not be surveyed as to changes from baseline experiences with ramp meters, signals, information signs, safety, changes in travel times and other specific measures of improvements until completion of all modules and the end oftest assessment

6. Summary of Results

The qualitative motorists, residents, and business operators data collected as part of this test plan will provide as good baseline for comparison of public perceptions after the implementation of Module 3.

The baseline survey data indicates that 80% of motorists find current freeway changeable message signs helpful and several motorists expressed support for additional CMSs. For those who do not find the CMSs helpful, they indicate the timeliness and accuracy of the information as not helpful. The survey also indicates that 75% of motorists do not use traffic information on a regular basis to plan trips. This baseline motorists perception of traffic information data will be helpful to assess the effects of the ICTM motorist information components.

The baseline survey data indicates that less than 40% of corridor motorists report frequent use the arterial street system. Of those motorists using the arterial street system, most site I-494 traffic congestion and long delays at entrance ramp meters as main factors in their route selection. The survey also indicates that almost half of all motorists surveyed will use the freeway for short trips. The survey indicates the perceived commuting time on I-494 is about 15 minutes and most motorists perceive their commuting time has remained the same or increased over the last year. Motorists perceived trip time on I-494 is fairly consistent. On a scale of 1 to 10 (10 being very consistent), motorists surveyed indicate a 7.23 consistency of travel time on the freeway. Motorists perceived delays at entrance ramp meters of slightly greater than 4 minutes and the majority of surveyed motorists indicate insufficient arterial street intersection signal timing. This baseline motorist perception of route selection and traffic operating conditions data will be helpful to assess the effects of ICTM to make the arterial street system more attractive for corridor motorists.

Motorist Information	Use of Freeway/Arterial Routes
• 80% of motorists find current traffic information on CMS helpful • 74% of motorists do not use traffic information to plan daily trips	• less than 10% of motorists use the arterial street system frequently • 46% of motorists are very *likely* or *extremely likely* to use the freeway for short trips • Motorists perceive average trip time of 15 minutes on I-l94 and has remained constant or increased in the prior to implementation of ICTM • Consistency of travel time rates 7.23 on a scale of 1 to 10, 10 = very consistent • **64.8%** of motorists express no concern over safety issues in the corridor
Ramp Meter Operations	**Arterial Signal Operations**
• 78% of motorists gain access to I-494 at metered entrance ramps • Motorists perceive ramp meter delays of just over 4 minutes	• 60% of corridor residents feel they stop a signals when there is no traffic in opposing direction

Test Han No. 8 - Legal and Institutional Issues

1. Test Purpose

The purpose of this test plan is to document all legal and institutional issues encountered during the ICTM Operational Test including resolutions to issues that impact participating agency policies, procedures and agreements. These issues and resolutions will, in-part, support the assessment of ICTM system expandability and transferability. This report only documents those legal and institutional issues relating to the development of the project and implementation of Modules 1 and 2 (adaptive control system). Complete assessment of the impacts of all ICTM legal and institutional issues and their impacts on system expandability and transferability will be presented in the final ICTM evaluation report.

2. Schedule of Test Activities

The activities in this test plan will be conducted on a continuous basis throughout the operational test. Results will be summarized in the interim and final evaluation reports after each module.

3. Analysis Methods

Analysis for this test plan involves documenting ICTM's legal and institutional issues and determining their impact on ICTM concept expandability and transferability. This activity involves: researching, reviewing and summarizing the information documented in the Appendix to this test plan; interviewing system operators and managers; and, reviewing relevant qualitative and quantitative results from other test plans for ICTM.

4. Results and Interpretations

A total of three measures of effectiveness (MOEs) pertaining to agreements, legal and institutional issues, and altered polices/procedures are documented in this test plan. Identification and documentation of information related to these MOEs is intended to be on-going throughout ICTM implementation. However, this interim report identifies only the multi-agency agreements, legal and institutional issues, and altered policies or procedures related to ICTM project development and implementation of Modules 1 and 2 (adaptive control system). Interviews with system operators and managers scheduled for early 1997 will provide will provide additional insights into these issues and will be reported on in the next interim report.

MOE 54.1 *Document all multi-agency agreements:*

Through file research and discussions with the Mn/DOT ICTM Project Manager, a listing of multi-agency agreements executed for ICTM Modules 1 and 2 has been prepared.

These agreements have been categorized into four types:

1. Municipal;
2. Congestion Mitigation and Air Quality (CMAQ);
3. Private Secton Partnerships; and,
4. Licensing.

A summary listing of each agreement, its description, and parties involved is found in Table A8-1.

Table A8-1. ICTM Module 1 and 2 Agreements

Agreement Type	Parties (Agencies)	Description
Municipal	Mn/DOT and City of Edina	Cooperative agreement for project cost sharing, maintenance, and operations. (Agreement No. 74863)
	Mn/DOT and City of Bloomington	Same as above. (Agreement No. 7486-F)
	Mn/DOT and City of Richfield	Cooperative Construction Agreement (CCA) for fiber optics communication installation on 77"' Street between Portland and Cedar Avenue. (Agreement No.72237)
	Mn/DOT and Hennepin County	CCA for Autoscope installation at four locations on Penn Avenue. (Agreement No. 72674)
Congestion Mitigation and Air Quality (CMAQ)	Mn/DOT, Cities of Bloomington, Edina, Richfield and Hennepin County	Funding/Cost Sharing for ICTM project staff support positions.
Private Sector Partnerships	Mn/DOT and AWA Traffic Systems America (AWATSA)	Acquisition of SCATS related hardware and software, and system support.
	MnDOT and Traffic Control Corporation (TCC)	Acquisition of Autoscope equipment and associated engineering support.
	Mn/DOT and Rennix Corporation	Acquisition of equipment necessary for detector technology testing and implementation.
Licensing	Mn/DOT and AWATSA	SCATS software, support and maintenance.

In addition to the Agreements described above, it is important to note that three types of Mn/DOT Contracts were also utilized for ICTM project development. A brief description of these contracts and how they were utilized for ICTM follow:

1. M-Contracts

M-Contracts are contracts for materials and services administered by the Minnesota Department of Administration and publicly advertised and bid.

Existing open ended M-Contracts were used for the purchase of the DEC computer to be used for the ICTM System Regional Computer.

The AWA Traffic Systems America contract was a sole source M-Contract under approval of the FHWA. The existing M-Contract with Ameridata was used to purchase PC hardware and software for remote workstations.

2. T-Contracts

T-Contracts are contracts administered by the Mn/DOT Traffic Engineering Office. Each T-Contract covers an area of specific expertise (i.e. signal design). Depending on the size of the contract, consultants may be selected sole source from a pre-approved list or invited to respond to an RFP in competition with other proposers. The T-Contracts were used in lieu of the Minnesota Guidestar Consultant list because Guidestar accounts were depicted at contract time.

A T-Contract was used, with Guidestar funding, for the hiring of Edwards & Kelcey, Inc. to do ICTM Master Planning. A T-Contract was also used to hire Westwood Services for initial development of the Evaluation Plan and for conducting a portion of “before” data collection activities.

3. Minnesota Guidestar Contracts

The Minnesota Guidestar Office maintains a pre-approved list of consultants to perform consultant services in designated areas for ITS projects. The selection procedures vary depending on contract amount. Consultant’s selected through the MN Guidestar procurement process were BRW, Inc. (Operations, Maintenance and Implementation Plans), Edwards and Kelcey, Inc. (Design), HNTB Corporation (Evaluation), Castle Rock Consultants (Technical Support), and Churchwood-Benson (Public Relations Planning).

MOE 5-4.2 *Document all legal or institutional issues encountered and the resolutions to those resolved: and*
MOE 5-4.3 *Document policies or procedures altered due to ICTM.*

Identification of legal and institutional issues and issues relating to agency policies or procedures was accomplished primarily through research of the ICTM Operations, Maintenance, and Implementation Plans. ICTM Management Team meeting minutes and Minnesota Guidestar Quarterly Progress Reports to the FHWA were also referenced as well as discussions with the Mn/DOT ICTM Project Manager. The results of this research is a compilation of key issues which are documented below in the categories of

1. Operations;
2. Maintenance; and,
3. Potential Liability.

1. Operation Issues:

Principal

a) The Agency that owns the particular traffic signal is responsible for operating and maintaining it.
b) The ICTM system operator is responsible for establishing incident response procedures, including route diversions, providing motorists information, utilizing extended ramp meter operation or assuming manual control of system elements.
c) If route diversions are used, predetermined route plans should be used where appropriate. The appropriate agency engineer should be notified of any route diversion conditions.
d) It is the ICTM system operator's responsibility to coordinate with the TMC Information Officer regarding response actions including manual overrides of system operation. The Information Officer is in charge of assessing the significance of an incident, notifying the appropriate authorities and assuring an adequate level of motorist information is disseminated to the public.
e) When manual control of ICTM system components within one's own jurisdiction is taken, that person shall notify appropriate representatives of the other affected jurisdictions.
f) The ICTM system provides the ability for jurisdiction to take control of another jurisdiction's system components. This may only be done provided prior arrangements and permission granted between the affected agencies.
g) Any agency should be able to control arterial VMS if not otherwise under the control of the Corridor Operation.

Other

a) Administration and upkeep of the Operations Plan shall be the responsibility of the ICTM Operations Engineer in conjunction with the ICTM Operations Committee.
b) VMS messages shall be concise and standardized.
c) VMS informational displays during normal operating conditions shall not be displayed on freeway VMS within the corridor.
d) New VMS messages should be reviewed and approved by the ICTM operations committee for future use.
e) The ICTM system operation shall directly coordinate with, and report all response procedures to the TMC's Information Officer. The TMC's Information Officer shall coordinate with the ICTM system operator in a similar manner.
f) If incident conditions could affect access to and from the Minneapolis-St.Paul International Airport, the manager should be notified such that motorist information can be displayed on the airport's existing VMS sign located at the exit to the airport.
g) A post incident review shall be completed to determine which items could be improved upon if a similar incident occurred in the future.
h) Training for all specialized equipment shall be provided by the equipment suppliers/manufacturers as part of specified contracts.
i) An independent evaluator shall establish a backup procedure for the regional computer to ensure data/information is not lost.
j) Each agency is responsible for making sure that their staff members are adequately trained on ICTM components.

2. Maintenance Issues:

Principal

a) Hennepin County, Bloomington, and Mn/DOT will work in their respective cabinets, and Hennepin County will be reimbursed for work in Edina and Richfield's cabinets.
b) All agencies shall utilize a standard traffic signal maintenance log form.
c) All agencies shall budget for annual replacement and service costs to maintain the system elements.
d) No master maintenance agreement is needed as long as appropriate municipal and signal agreements are developed to identify cost sharing and maintenance responsibilities.

Other

a) Each agency shall develop/utilize written preventive maintenance procedures.
b) Each agency shall setup contracts on a time and material basis for maintenance support of specialized equipment.

c) All new equipment to be installed as part of the ICTM project shall have a minimum 12-month warranty on parts and labor with ongoing technical support throughout the operational test.
d) Maintenance records shall be retained for a minimum of seven years.

3. Potential Liability Issues:

a) The legal authority of one agency to enter a cabinet or intersection of another agency and related possible liability when assisting with traffic management operations and maintenance outside an agency's jurisdiction..
b) Uniform procedural and standard practice issues such as when in another agency's cabinet and consistency in making log entries.

The Operations, Maintenance, and Potential Liability issues/areas described above will be the basis for development of interview questions for system operators and managers. The results of the interviews will provide further insight into the impacts these issues have on ICTM system expandability and transferability. Results will be documented in future interim reports as well as the final Evaluation Report.

ICTM DOCUMENT REVIEW

The following list is a complete compilation of the of agreements, legal issues, institutional issues, and policies altered that are identified in each of the documents reviewed.

A. ICTM Proposal for Operational Test

B. ICTM Operations Plan

C. ICTM Implementation Plan

D. ICTM Maintenance Plan

E. Management Team Meetings

F. I-494 ICTM Workshops VI

G. Minnesota Guidestar Quarterly Progress Report to the FHWA

A. ICTM Proposal for Operational Test

No specific multi-agency agreements were identified in the proposal for the Operational Test. However, the descriptions of the agreements which would be made once the Operational Test was underway are described. These agreements include the following:

<u>Incident Management Plan</u> - A comprehensive incident management plan is an essential component of ICTM. During Module 1 incident management plans will be developed to address all possible incident types.

<u>Special Event Management</u> - An additional feature of the ICTM system will be its ability to manage planned, unusual are "special" events. Since control is integrated throughout the corridor, more effective movement both to and from the event can be achieved. Strategies will be developed and implemented for the entire corridor.

<u>Traveler Information</u> - Successful and timely delivery of information to corridor users will be necessary to accomplish the goals and objectives of the incident and special event strategies. An extensive motorist information network will be used for that purpose. The key components of this program will be fixed and portabie CMSs, fixed route guidance signs, HAR, cable television, commercial radio and motorist information stations.

<u>Emergency Pre-Emption</u> - To maintain consistency throughout the State of Minnesota, a light-emitting system has been adopted as the standard for emergency vehicle pre-emption. The Cities of Bloomington and Richfield have extensively employed emergency pre-emption equipment within their jurisdictions. Upgrades with this system are planned on all existing routes scheduled for reconstruction in the corridor. There are five locations where the pre-empt system will be upgraded to conform with current standards.

B. ICTM Operations Plan

The following is a summary of the agreements included in the Operations Plan:

From Chapter 1, section 1.3, The administration and upkeep of the Operations Plan shall be the responsibility of the ICTM operations Engineer in conjunction with the ICTM Operations Committee.

From Chapter 4, Section 4.2, the following goals were defined for the operation of the ICTM System during normal operating conditions. These goals were identified and prioritized through workshops with all the project partners.

Goal	Decription
1	Establish Reliable and Consistent Trips Within the Project Corridor
2	Encourage the Motorist to Use Local Streets for Short Trips
3	Better Utilization of Existing Roadway Infrastructure
4	Minimize Freeway to Freeway Ramp Degradation
5	Eliminate Off-ramp Queues Which Extend onto the mainline Freeway
6	Eliminate On-ramp Queues Which Extend Back to the Arterial
7	Maintain ArterialTraffic Flow Through the Interchange Area
8	Provide Ramp Queue and Traffic Responsive Metering

In regards to the use of VMS messages, Chapter 4, Section 4.3.4 discusses the following operational procedures:

- VMS messages shall be concise and standardized.
- Informational displays during normal operating conditions shall not be displayed on freeway VMS within the corridor. Local jurisdictions may display civic messages with the approval of the ICTM operations comments.
- New messages should be reviewed and approved by the ICTM operations committee for future use.

From Chapter 5, Section 5-3.3, the Operations Plan describes the following System Operator response procedures during an incident.

- The ICTM System Operator is responsible for establishing incident response procedures, including route diversions, providing motorist information, utilizing extended ramp meter operation or assuming manual control of system elements.

- If route diversions are used, predefined route diversion plans should be used where appropriate. The appropriate agency engineer should be notified of any route diversion conditions.

- Extended ramp metering operations should only be considered under severe and extended incident situations.

- It is the ICTM System Operator's responsibility to coordinate with the TMC Information Officer regarding response actions including manual overrides of system operation. The Information Officer is in charge of assessing the significance of an incident, notifying the appropriate authorities and assuring that an adequate level of motorist information is disseminated to the public.

During manual intervention of the ICTM system, the following coordination guidelines shall be followed:

- When manual contro1 of ICTM system components within one's own jurisdiction is taken, that person shall notify appropriate representatives of the other affected jurisdictions.

- The ICTM System Operator shall directly coordinate with, and report all response procedures to the TMC's Information Officer. The TMC's Information Officer shall coordinate with the ICTM System Operator in a similar manner.

- The ICTM system provides the ability for a jurisdiction to take control of another jurisdiction's system components. This may only be done provided prior arrangements and permission is granted between the affected agencies.

- If incident conditions could affect access to and from the Minneapolis-St. Paul International Airport, the airport manager should be notified such that motorist information can be displayed on the airport's existing VMS sign located at the exit to the airport.

- A post incident review shall be completed to determine which items could be improved upon if a similar incident occurred in the future.

C. ICTM Implementation Plan

- M-Contracts:

M-Contracts are contracts for materials and services administered by the Minnesota Department of Administration and publicly advertised and bid.

Existing open ended M-Contract were used for the purchaser of the DEC computer for the Regional Computer.

The AWA Traffic Systems America contract was a sole source M-Contract under approval of the FHWA. The existing M-Contract with Ameridata was used to purchase PC hardware and software for remote workstations.

- T-Contracts:

T-Contracts are contracts administered by the Mn/DOT Traffic Engineering Office. Each T-Contract covers an area of specific expertise (i.e. signal design). Depending on the size of the contract, consultants may be selected sole source from a pre-approved list or invited to respond to an RFP in competition with other proposers. The T-Contracts were used in lieu of the MN Guidestar Consultant list because the MN Guidestar accounts were depleted.

A T-Contract was used for the hiring of Edwards & Kelsey to do ICTM Master Planning, using Guidestar funding **A** T-Contract was also used to hire Westwood Services for development of the Evaluation Plan and for conducting some "before" data collection.

- MN Guidestar Contracts:

The MN Guidestar Office maintains a pre-approved list of consultants to perform consultant services in designated areas for ITS projects. The selection procedures vary depending on contract amount. Consultant's-selected through the MN Guidestar procurement process were BRW, Inc. (Operations, Maintenance and Implementation Plans), HNTB Corp. (Evaluation Design and Implementation), Castle Rock Consultants (Technical Support), and Churchwood-Benson (Public Relations Planning).

- Private Sector Partnership Agreements:

Private Sector Partnership Agreements allow Mn/DOT to enter into agreements with non-governmental entities for research and experimentation; for sharing facilities, equipment, staff, data, or other means of providing transportation-related services; or for other cooperative programs that promote efficiencies in providing governmental services or that promote efficiencies in providing governmental services or that further development of innovation in transportation for the benefit of the citizens of Minnesota.

A Private Sector Partnership Agreement was negotiated with Rennix Corporation for the acquisition of equipment necessary for the implementation and testing of detector technologies (3M Canoga System). A Private Sector Agreement was also negotiated with Traffic Control Corporation for the purchase of Autoscope System equipment and associated engineering support.

- Licensing Agreements:

SCATS System software and support were purchased through a software licensing agreement with the State of Minnesota. An annual maintenance agreement has also been purchased which also includes software upgrades.

State of Minnesota Department of Administration's Cooperative Purchasing Venture (CPV) Program

The CPV program allows political subdivisions of the state to purchase materials and services directly from state contract vendors. Hennepin County and the cities of Bloomington, Edina and Richfield are all members of the CPV program and are eligible to purchase equipment under the Rennix and Traffic Control Products Agreements, as well as any other existing M-Contract.

D. ICTM Maintenance Plan

The ICTM Maintenance Plan lists areas of possible liability which need to be addressed by the participating agencies in the Operational Plan. These areas include:

- Possible liability when assisting with traffic management operations and maintenance outside of an agency's jurisdiction.
- The legal authority of one agency to enter a cabinet or intersection of another agency.
- Uniform procedural issues such as when in another agencies cabinet and consistency in making log entries.
- Uniform maintenance practices such as cable assignments, labeling of cables or equipment, documenting cabinet modifications, etc.
- How to legally handle priorities of maintenance response and how the ICTM maintenance tasks fit into each agency's other priorities.
- The need to produce written documents that identify minimum preventive maintenance procedures for tort liability reasons.

Maintenance Plan recommendations:

- Training for all specialized equipment shall be provided by the equipment suppliers/manufacturers as part of specific contracts.
- Each agency shall develop / utilize written preventive maintenance procedures.
- Each agency shall setup contracts on a time and material basis for maintenance support of specialized equipment.
- All new equipment to be installed as part of the ICTM project shall have a minimum 12-month warranty on parts and labor with ongoing technical support throughout the operational test.
- An independent evaluator shall determine if a separate database management program should be purchased or developed for the ICTM project.
- An independent evaluator shall establish a backup procedure for the regional computer to ensure data/information is not lost.
- All agencies shall utilize a standard traffic signal log form.
- Maintenance records shall be retained for a minimum of seven years.
- Each agency is responsible for making sure that their staff members are adequately trained on the ICTM components.
- A limited number of spare components are required for the ICTM project.
- Laptop computers shall be available for agency support staff to allow access of the regional computer to perform remote diagnostics.
- Annual maintenance agreements shall be written and maintained for the DEC equipment and SCATS software.
- All agencies shall budget for annual replacement and service costs to maintain the system elements.
- No master maintenance agreement is needed as long as appropriate municipal and signal agreements are developed to identify cost sharing and maintenance responsibilities.

E. Management Team Meetings

Management Team Meetings were held approximately once per month, beginning in October, 1993. A review of the meeting minutes indicates that the meetings primarily involved progress updates for all aspects of the ICTM project. The meeting minutes gave no specifics as to legal or institutional issues. The following entry from the January 4, 1996 meeting is the most specific discussion regarding institutional issues in all of the Management Team meeting minutes.

January 4. 1996:

Module 3 controller cabinet change outs will be handled jointly by the cities and county rather than through the consultant.

Jerry Smrcka informed the group that work done in Hennepin County signal cabinets should be performed by Hennepin County personnel rather than Edwards & Kelsey. It was agreed that Hennepin County, Bloomington and Mn/DOT will work in their respective cabinets, and Hennepin County will be reimbursed for work in Edina and Richfield's cabinets. Jerry estimated the cost at $500 per cabinet.

F. I-494 ICTM Workshop VI

October 12, 1995:

A discussion of message control was conducted, based on Phil Cornwell's discussion paper and the feeling of the individual agencies. The base agreement was that any agency should be able to control arterial VMS if not otherwise under the control of the Corridor Operator.

G. Minnesota Guidestar Quarterly Progress Reports to the FHWA

- October 1 - December 31, 1993:

  Different funding cycles for the local agencies, State and Federal Governments has complicated planning for future modules and identification of match dollars needed.

  A lack of clearly defined procedures for processing expenditures is causing delays in processing department purchase orders, request for proposals and consultant agreements.

Liability, indemnification and multi-jurisdictional ownership issues have delayed finalization of the SCATS software license and AWATSA agreements.

- January 1 - March 31, 1994:

Different funding cycles for the local agencies, State and Federal Governments has complicated planning for future modules and identification of match dollars needed.

A lack of clearly defined procedures for processing expenditures is causing delays in processing department purchase orders, request for proposals and consultant agreements.

Liability, indemnification and multi-jurisdictional ownership issues have delayed finalization of the SCATS software license, AWATSA agreements and SCATS peripherals.

Identification of the available communication infrastructure has been more complex and time consuming than anticipated. A detailed analysis of the communications requirements has revealed that initial budget forecasts were underestimated. The mechanism to address unforeseen expenditures was not clearly defined.

Tracking and reporting in-kind and hard contributions by project participants does not coincide with cost accounting system.

- April 1 - June 31. 1994:

The integration of the SCATS and Freeway Management Systems to meet the needs and expectations of both the project and participating agencies without compromising either system's operations is a challenge.

Maintaining effective communications between the various organizations is a challenge with the dynamic nature of the operational tests.

Hardware limitations within the existing Freeway Traffic Management System restrict the capabilities available to the agencies. (e.g. the number of ports available on the communication switcher at Mn/DOT's Traffic Management Center)

A lack of clearly defined procedures for processing expenditures is causing delays in processing department purchase orders, request for proposals and consultant agreements.

Liability, indemnification and multi-jurisdictional ownership issues have delayed finalization of the SCATS software license and transfer of peripherals ownership to other agencies.

Working out the entire project's communication requirements, when all the project components have not been clearly defined, is extremely difficult.

Programming decisions outside of our control are causing project delays. Budget shortfalls force programming changes that push back state and local construction projects within the I-494 corridor. These infrastructure improvements are essential to effectively implement the SCAT system. The delay directly impacts our ability to move traffic within the corridor.

- July 1 - September 30. 1994:

Keeping key persons from each agency informed of ICTM project activities and intentions and assuring that this information is disseminated to the appropriate personnel within each agency.

Use of advanced technologies in which departmental policy is pending investigation.

Timely review of potential private sector partners proposals.

Satisfying project requirement while maintaining the agreed upon distribution of responsibilities.

- October 1 - December 3 1. 1994:

Keeping key persons from each agency informed of ICTM project activities and intentions and assuring that this information is disseminated to the appropriate personnel within each agency.

Coordination of agreement writing. Satisfying each agency's legal requirements without compromising another's.

Evaluation Plan timeline and format.

Mixed TMC involvement and support of project goals.

Education and buy-in of other Mn/DOT functional areas to understand the project and the partnership philosophy.

Educating the agencies on each other's policies, procedures and required timelines

- January 1 - March 31. 1995:

  Developing Municipal and Cooperative agreements that will satisfy multiple agencies legal requirements.

  Develop an Evaluation Plan that fulfills FHWA requirements, meets project expectations and budget and time constraints.

  Keeping the project on track with the additional responsibilities required by FHWA and CMAQ.

  Having the resources necessary to effectively complete the work charged to the ICTM working committees.

- April 1 - June 30. 1995:

  A great deal of effort has been put forth to assure that the Operations Committee accomplish the tasks it has been charged. Due to the dynamics of this project and the multi-responsibilities of each of its members, the committee has had to face several challenges, including:

  - Achieving active participation from all members on a continuous basis.
  - Maintaining commitment levels.
  - Developing system operational procedures that meet the needs of the multi-agencies.

  Some overall project challenges include:

  - Developing Municipal and Cooperative Agreements that will satisfy multiple agencies legal requirements.
  - Develop an Evaluation Design that fulfills FHWA requirements and meets project participants' expectations.
  - Coordinating construction activities that involve multiple agencies and private sector partners.

- July 1 - September 30, 1995:

  The primary challenge in the evaluation effort for this quarter was ensuring that all necessary "before" data was collected prior to the implementation of ICTM Module l&2 components. This challenge was successfully met through a fast-track assessment of "before" data needs and an expedited field data collection effort. The cooperation and assistance from the participating agencies greatly contributed to the success of this critical phase of the evaluation data collection.

  Upcoming challenges include developing the Individual Evaluation Test Plan (IETP) descriptions for the ICTM evaluation effort, and determining the most cost effective and practical means of conducting the evaluation. Technical support and assistance is being provided by Booz-Allen and FHWA.

  Coordinating construction activities and determining creative ways to address field problems, partners responsibilities, and technical issues is an on-going challenge when multiple agencies and private sector partners are involved.

- January 1 - March 31, 1996:

  Conduct the project evaluation within the limited budget allocated. HNTB and ICTM evaluation team will monitor activities and set target values for completion of each task.

  Constructing the communication network and implementing the 45 traffic signals within the construction season. The Operations committee is meeting every two weeks to keep the agencies abreast of progress, coordinate agency activities, and address field problems.

  Maintaining a balanced budget when there are unforeseen expenditures and consultant overruns that are necessary to implement the system.

  Maintaining interagency cooperation given the dynamics of project activities and the workload agency staffs are facing.

Summary of ICTM Modules 1 and 2 Data Management Activities

Data Element	Test Plan	Data Collection	Data Validation	Data Storage and Security
Traffic Related Data				
Screenline Traffic Volumes	IETP #1	Collected at two freeway locations using loop detectors and five arterial street locations using portable road tubes.	Hourly volumes checked if reasonable. Compared daily and hourly averages with historic data. Reviewed TMC Incident Log and removed incident-affected volumes.	Screenline Volume data files were Imported into an Excel spreadsheet to create a consistent format. Files are saved on HNTB’s Minnesota office network and archived on Helical-Scan 4mm cartridges and stored at the office’s off-site storage location.
Freeway and Arterial Street Travel Times	IETP #2 and 4	Collected on one freeway route and eleven arterial street routes using vehicles equipped with Jamar travel time/distance measuring devices.	Reviewed by data collectors and compared to their in-field observations. Compared with intersection queue length/cycle failure data and historic travel time data. Segment lengths and travel time verified by personnel with local familiarity of corridor.	Travel Time data files were Imported into an Excel spreadsheet for analysis. Files are saved on HNTB’s Minnesota office network and archived on Helical-Scan 4mm cartridges and stored at the office’s off-site storage location.
Ramp Meter Queue Lengths	IETP #2	Collected manually in the field by participating agencies al eight sample ramp meter locations.	Ramp meter operations confirmed by cross referencing with SCATS system liming plans. Data reviewed to ensure correct procedures were followed	Manually collected data was entered into an Excel Spreadsheet to create electronic files. Files are saved on HNTB’s Minnesota office network and archived on Helical-Scan 4mm cartridges and stored at the office’s off-site storage location.
Ramp Meter Timing Plans	IETP #2	Collected automatically by the ICTM regional computer at eight sample ramp meter locations	Timing plan data confirmed by cross referencing with ramp meter queue length data.	Meter timing plan data files were imported into an Excel spreadsheet for analysis. Files are saved on HNTB’s Minnesota office network and archived on Helical-Scan 4mm cartridges and stored at the office’s off-site storage location.
Entrance Ramp Volumes	IETP #2	Collected automatically using loop detectors and the TMC operations computer at six sample ramp meter locations.	Compared with historic ramp volume data and verified by personnel with local familiarity of corridor.	Ramp volume data files were imported into an Excel spreadsheet for analysis. Files are saved on HNTB’s Minnesota office network and archived on Helical-Scan 4mm cartridges and stored at the office’s off-site storage location.

Summary of ICTM Modules 1 and 2 Data Management Activities

Data Element	Test Plan	Data Collection	Data Validation	Data Storage and Security
Traffic Related Data (cont'd)				
Intersection Queue Lengths and Cycle Failures	IETP #2	Collected manually in the field by participating agencies at six intersections	Cross referenced with stop time delay data collected through travel Lime runs. Data reviewed to ensure correct procedures were followed and compared to historic data.	Manually collected data was entered into an Excel Spreadsheet to create electronic files. Files are saved on HNTB's Minnesota office network and archived on Helical-Scan 4mm cartridges and stored at the office's off-site storage location.
Intersection Turning Movement Counts	IETP #2	Collected in the field using Jamar countboards by participating agencies at six intersections.	Cross-referenced with screenline volume data and historic turning movement counts.	Turning Movement data files are saved on HNTB's Minnesota office network and archived on Helical-Scan 4mm cartridges and stored at the office's off-site storage location.
Freeway Incidents	IETP #1	Collected and compiled by Mn/DOT Traffic Management Center staff.	No validation conducted by the Evaluation Contractor.	TMC Incident Log data was imported into an Excel spreadsheet for analysis. Files are saved on HNTB's Minnesota office network and archived on Helical-Scan 4mm cartridges and stored at the office's off-site storage location.
Corridor Accidents	IETP #4	Reported by state, county and city law enforcement agencies and compiled in the Mn/DOT Transportation Information System (TIS) database.	No validation conducted by the Evaluation Contractor.	Mn/DOT TIS data was imported into an Excel spreadsheet and sorted for analysis. Files are saved on HNTB's Minnesota office network and archived on Helical-Scan 4mm cartridges and stored at the office's off-site storage location.

Summary of ICTM Modules 1 and 2 Data Management Activities

Data Element	Test Plan	Data Collection	Data Validation	Data Storage and Security
User Perception Data				
Corridor Resident Perception	**IETP #7**	Baseline perceptions collected through focus group meetings.	FOCUS group moderator's guide reviewed by ICTM Evaluation Committee prior to use.	Transcripts of the focus groups are retained and archived in digital format on removable tape cartridges.
Corridor Business Operator Perception	**IETP #7**	Baseline perceptions collected through focus group meetings.	Focus group meetings recorded on audio and video tapes and attended by ICTM Evaluation Committee members.	Audio/video tapes were copied and originals stored at a separate site.
Corridor Motorist Perception	**IETP #7**	Baseline perceptions collected through telephone surveys using computer aided telephone interviewing (CATI) technology.	Survey questions reviewed by ICTM Evaluation Committee prior to use. Supervisor monitored of data collection, quotas and responses examined daily, random sampling, screened subject, and over sampled.	Interview data was entered into a computer control file and referenced by a unique respondent number. Control files are archived in digital format on removable tape cartridges.
Other Relevant Data				
Costs and Contributions	IETP #5	Documented based on ICTM Project Manager records and Quarterly Progress Reports.	Documented costs compared to avoid duplication. Compared costs of similar items from each agency.	Costs were compiled and summarized in Microsoft Office format. Files are saved on HNTB's Milwaukee office network and archived on removable tape cartridges.
Agreements	IETP #6 and 8	Documented based on ICTM Proposal, Implementation Plan, Operations Plan, Maintenance Plan, and meetings with the ICTM Project Manager.	No validation completed at this point in the evaluation.	Agreements were compiled and summarized in Microsoft Office format. Files are saved on HNTB's Milwaukee office network and archived on removable tape cartridges.
Legal/Institutional Issues	IETP #8	Documented based on ICTM Management Operations, and Maintenance meeting minutes and Meetings with the ICTM Project Managers.	No validation completed at this point in the evaluation.	Legal/Institutional Issues were compiled and summarized in Microsoft Office format. Files are saved on HNTB's Milwaukee office network and archived on removable tape cartridges.
Policy and Procedures	IETP #8	Documented based on ICTM Management Operations, and Maintenance meeting minutes and Meetings with the ICTM Project Managers.	No validation completed at this point in the evaluation.	Policy and Procedures were compiled and summarized in Microsoft Office format. Files are saved on HNTB's Milwaukee office network and archived on removable tape cartridges.